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**Mitelberg**

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(54) **ENDOSCOPIC SUTURE CINCH**

(71) Applicant: **Apollo Endosurgery, Inc.**, Austin, TX (US)

(72) Inventor: **Vladimir Mitelberg**, Austin, TX (US)

(73) Assignee: **Apollo Endosurgery US, Inc.**, Austin, TX (US)

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**A61B 17/00** (2006.01)

(52) **U.S. Cl.**

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*Primary Examiner* — Elizabeth Houston

*Assistant Examiner* — Kankindi Rwego

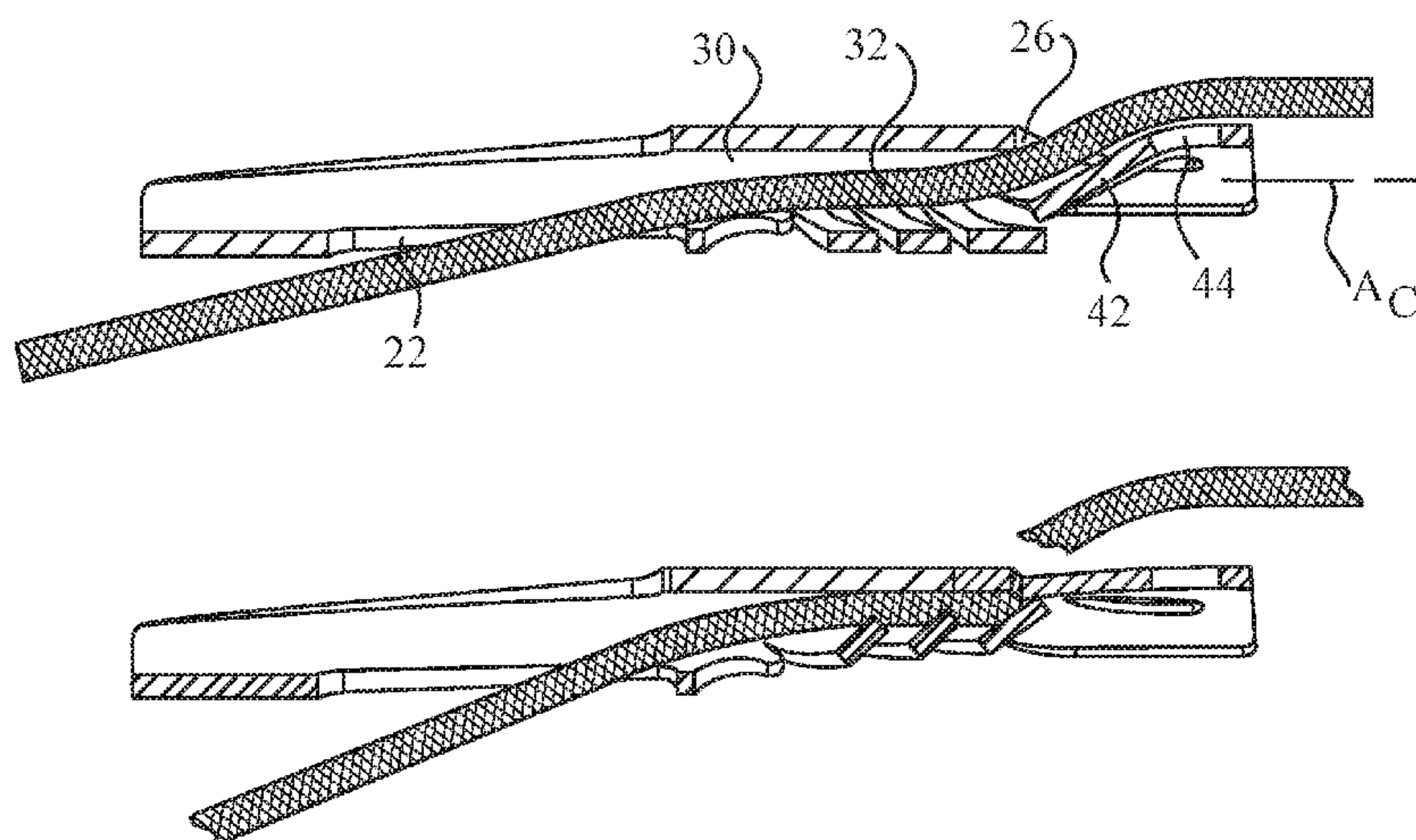
(74) *Attorney, Agent, or Firm* — Donald K. Jones

(57)

**ABSTRACT**

A suture cinch, cinch applicator, and cinch loader for loading the cinch into the applicator are provided and permit re-use of the applicator with multiple cinches during an endoscopic procedure. The applicator can be loaded with a first cinch, apply the first cinch onto a portion of suture to fix the portion of suture relative to anatomical tissue, reloaded with a second cinch optionally using the loader, and subsequently used to apply the second cinch to fix another portion of suture to fix the other portion of suture relative to anatomical tissue. The cinch is a unitary tubular member through which the suture can be advanced when the cinch is loaded within the applicator. The cinch defines multiple ribs and a cutter in a wall thereof. Operation of the applicator deforms the ribs inward to retain the cinch on the suture and displaces the cutter to sever the suture.

**20 Claims, 10 Drawing Sheets**



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See application file for complete search history.

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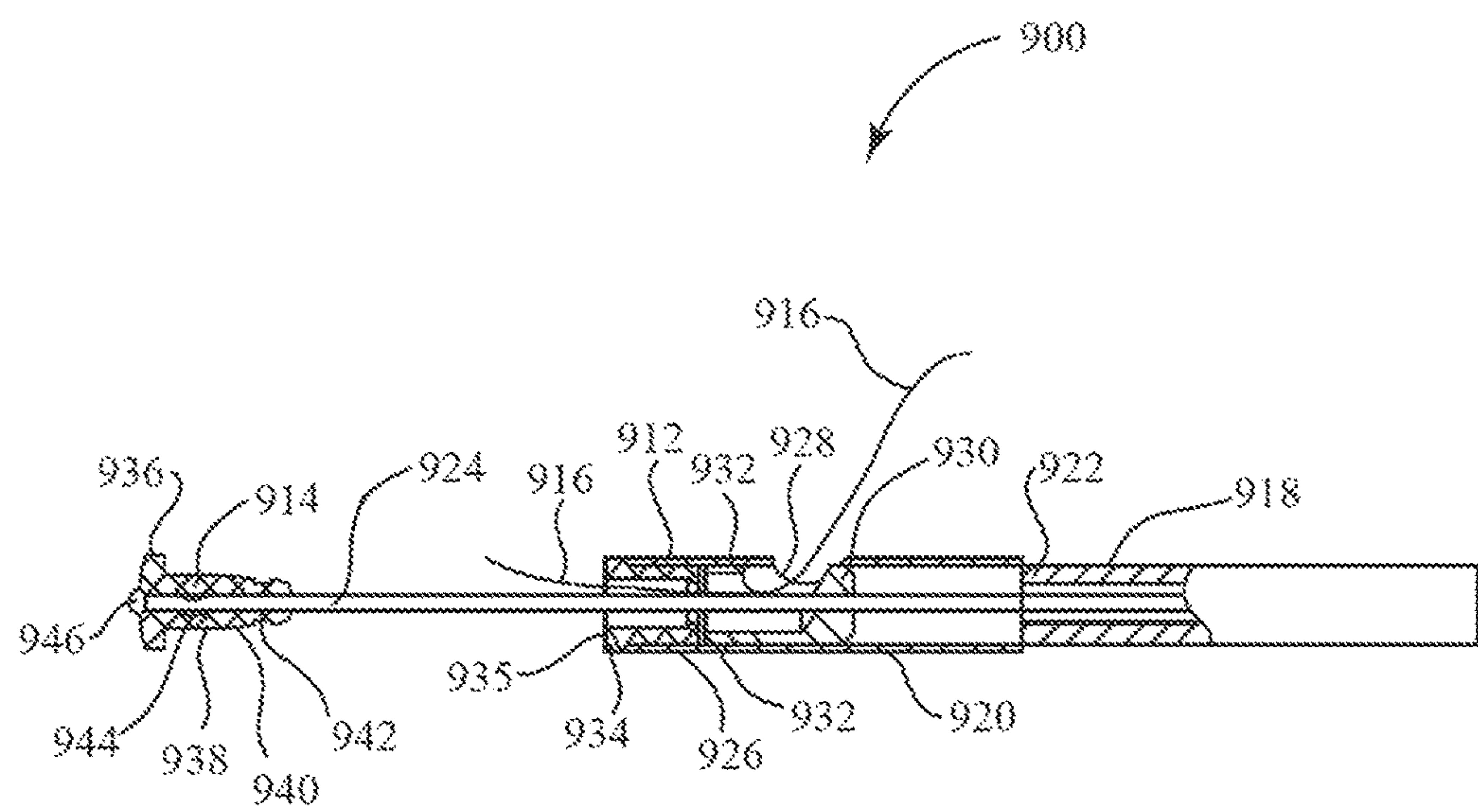
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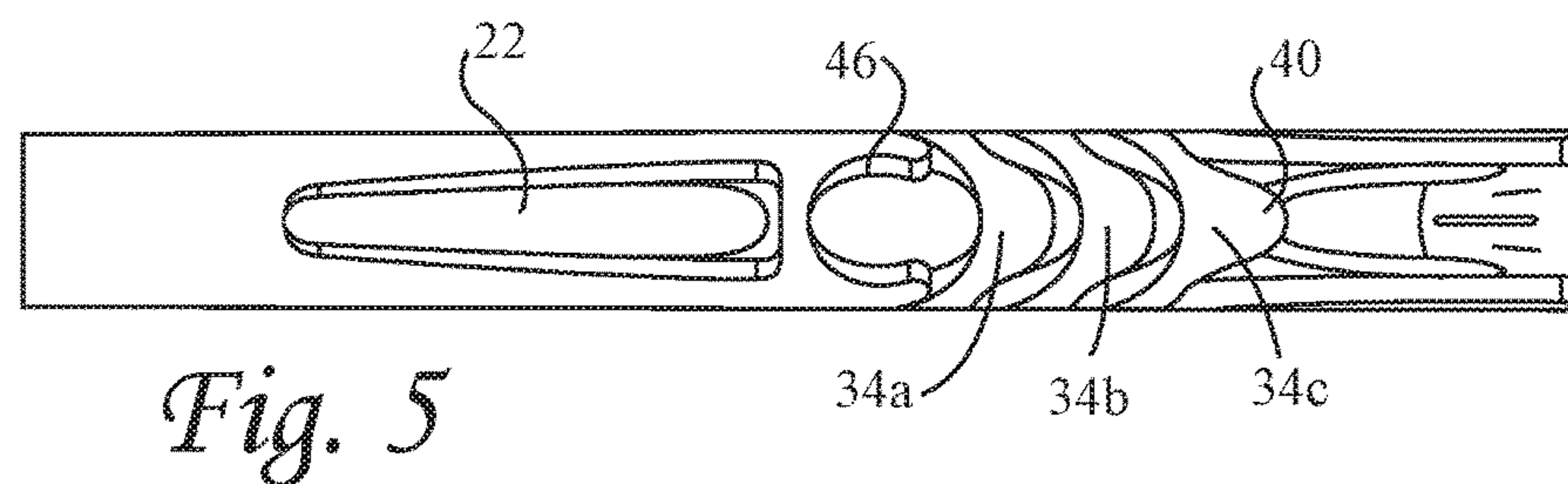
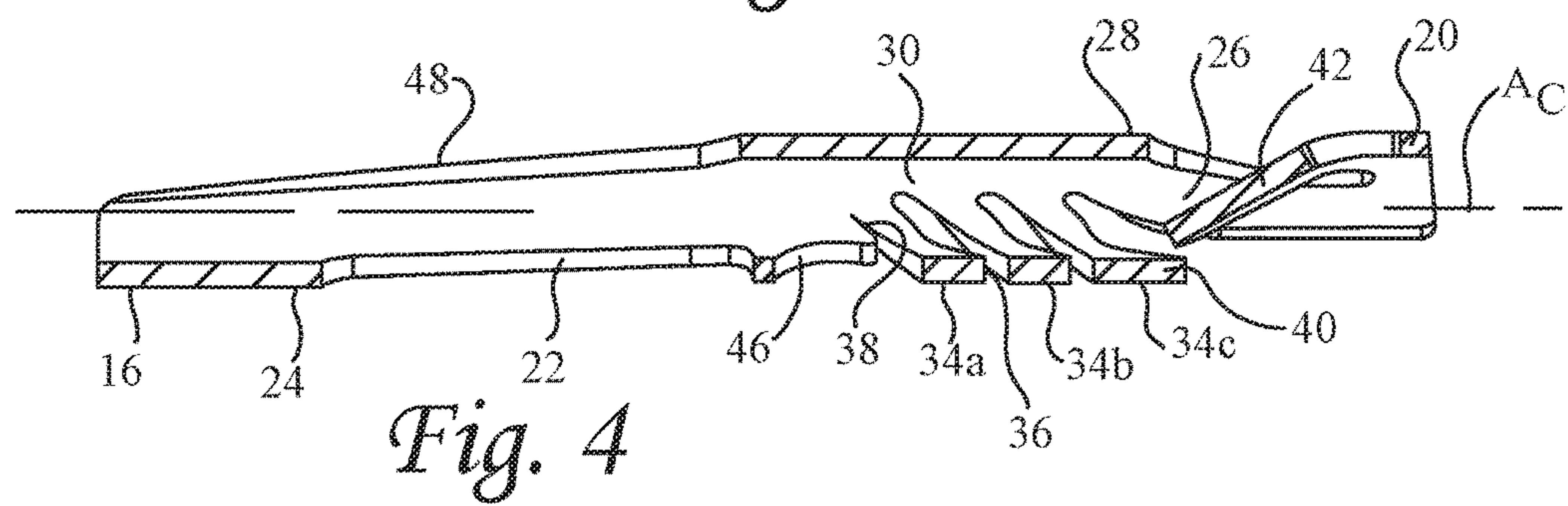
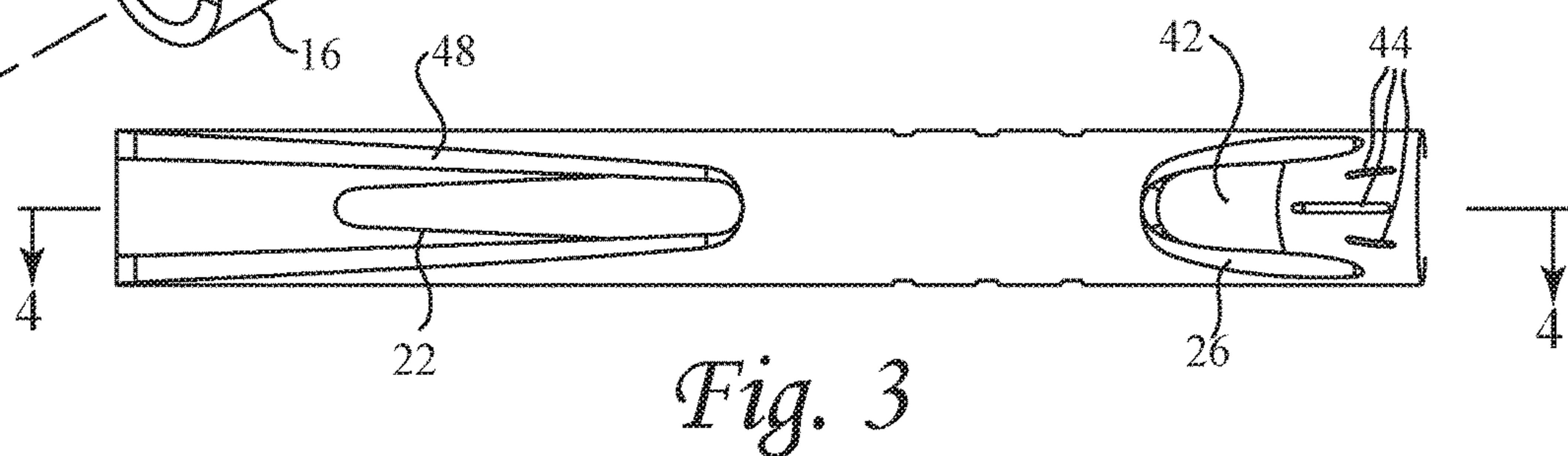
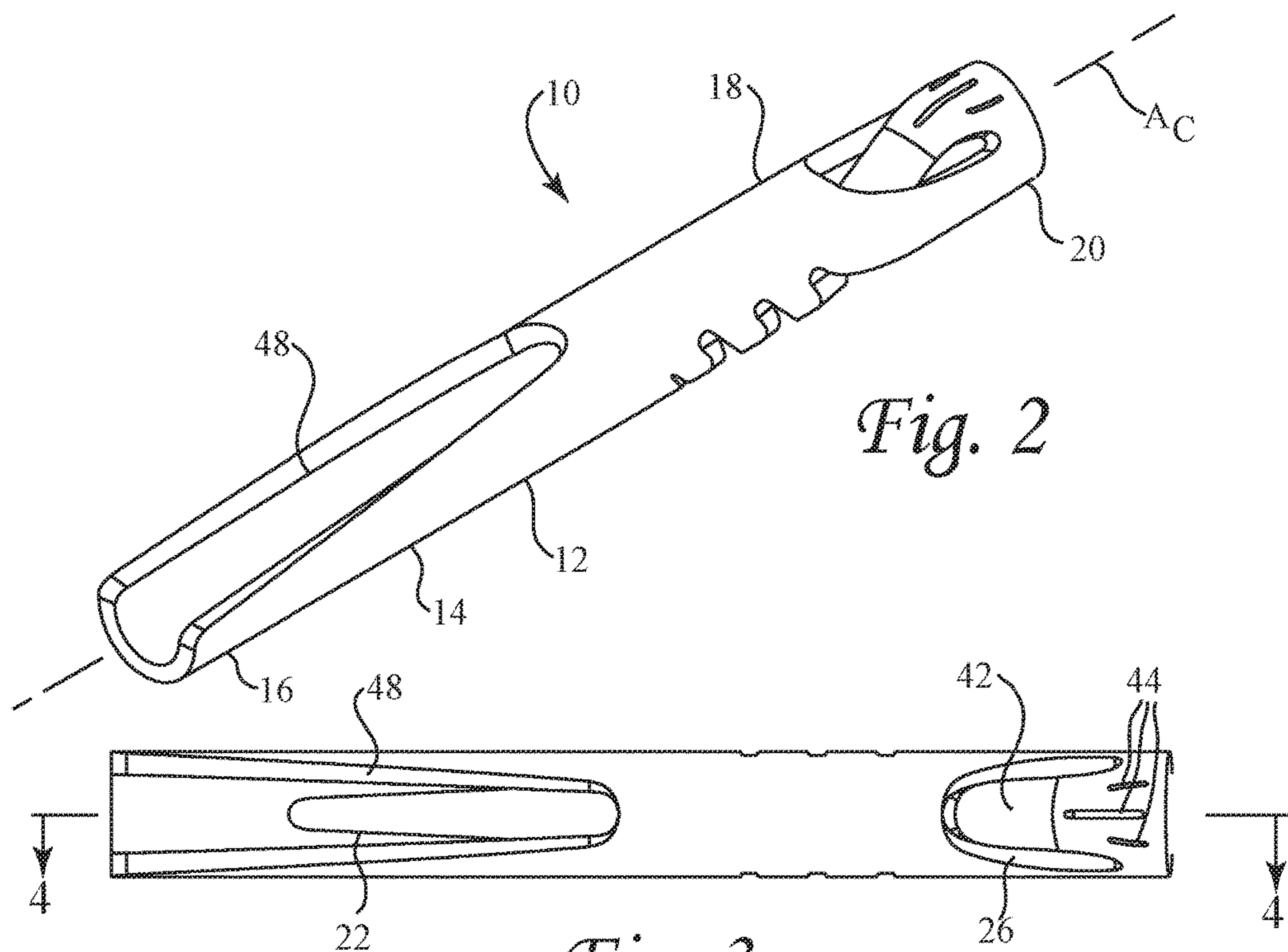
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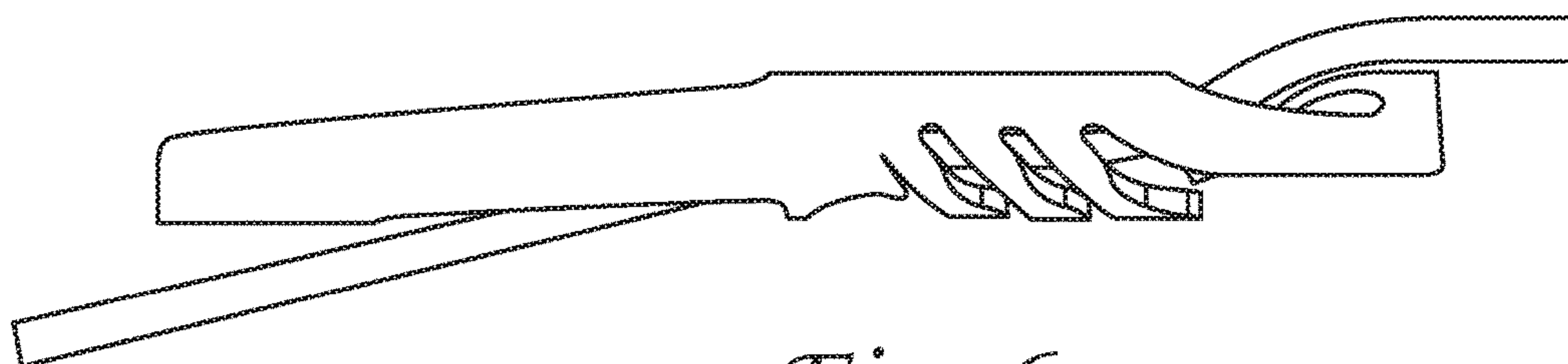
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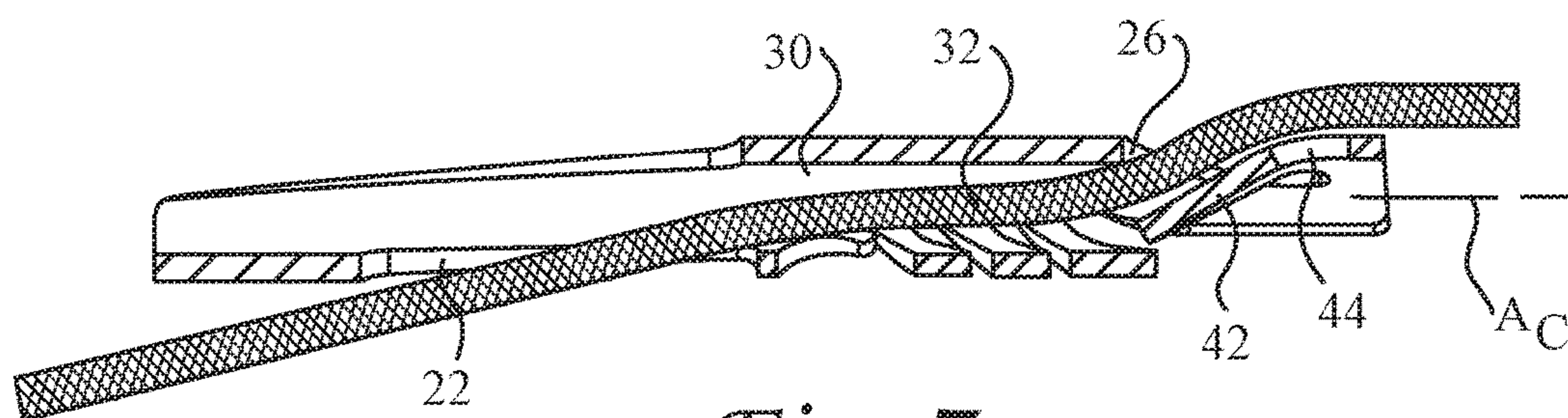


*Fig. 1*  
Prior Art

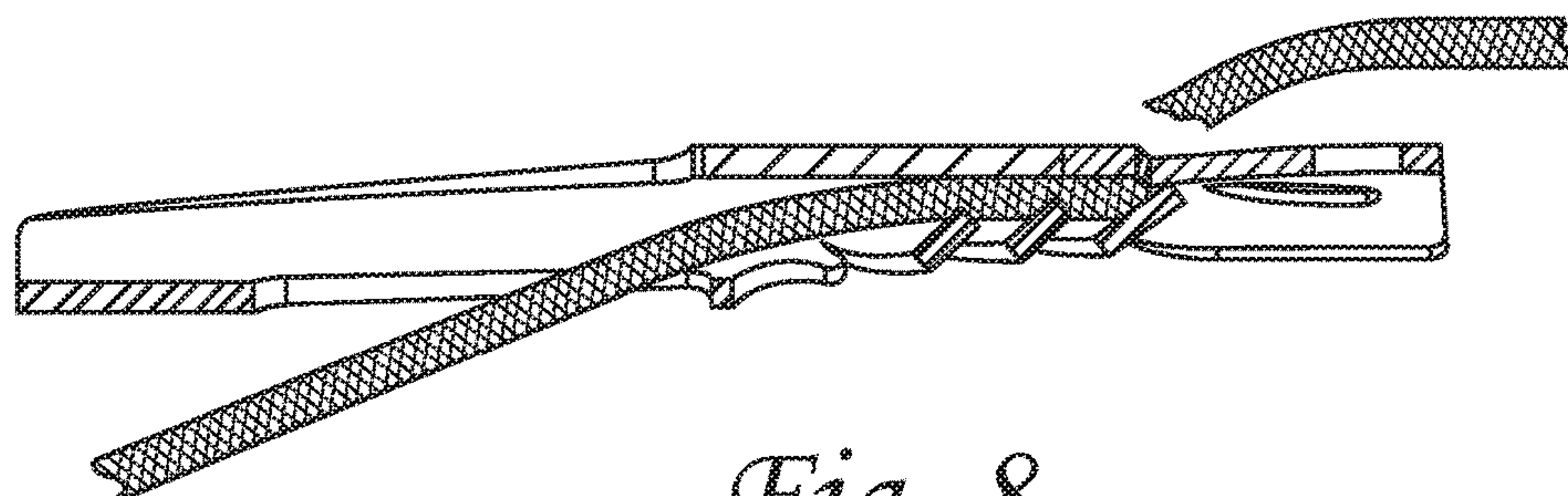




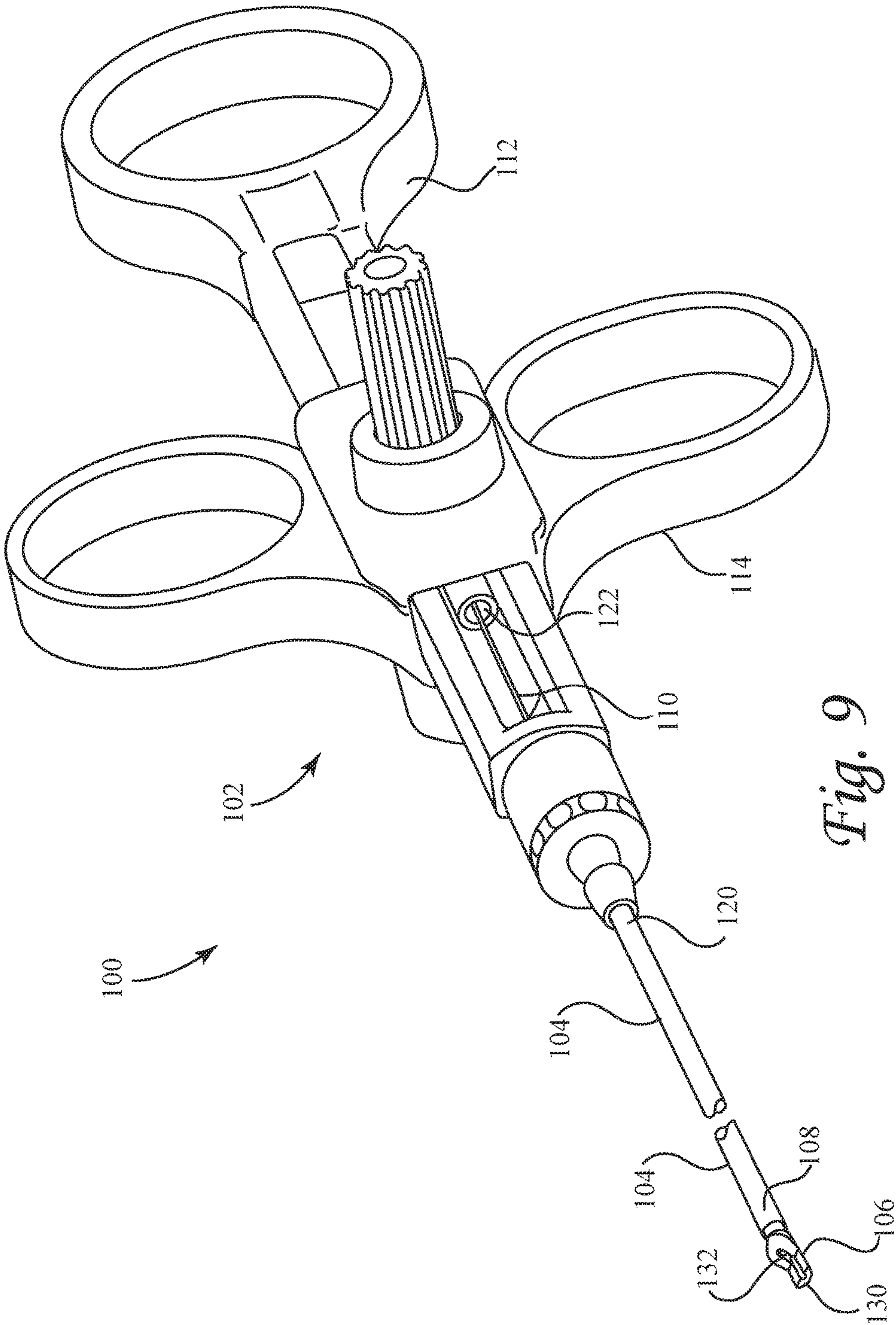
*Fig. 6*



*Fig. 7*



*Fig. 8*





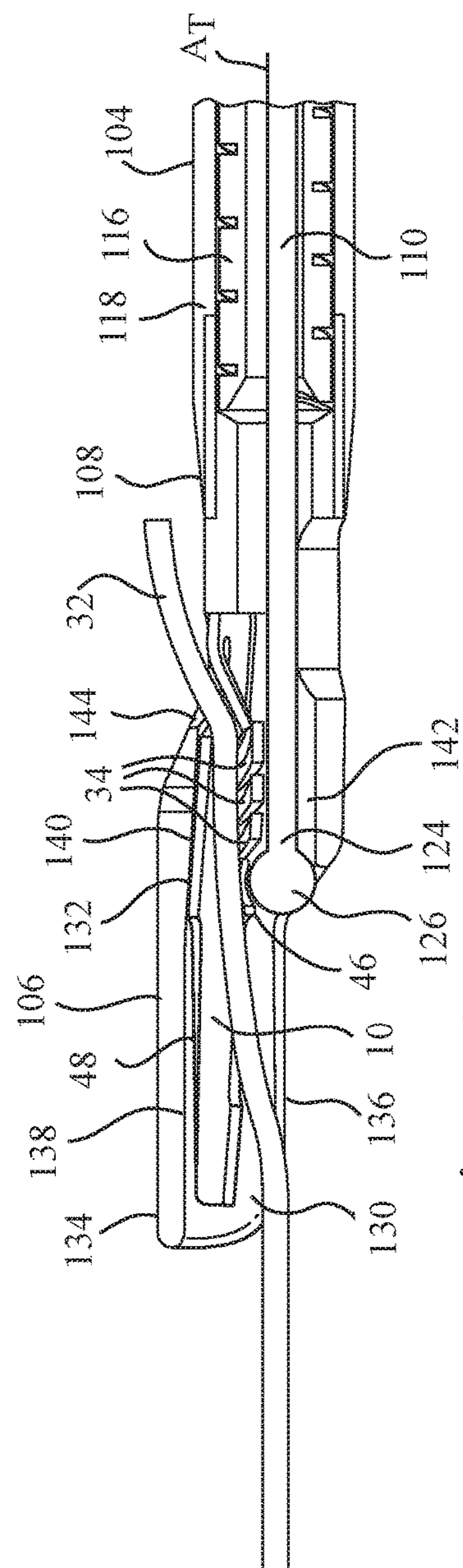


Fig. 10

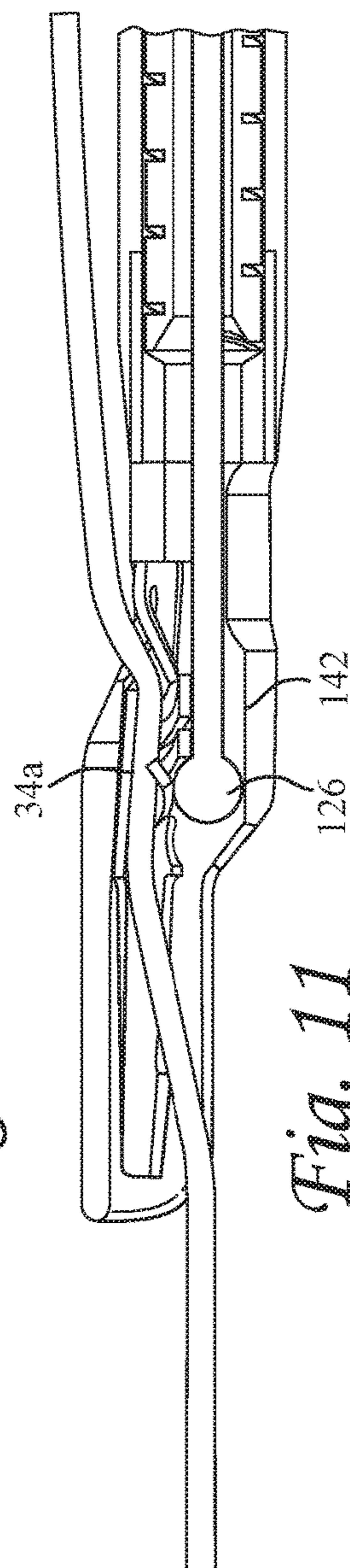


Fig. 11

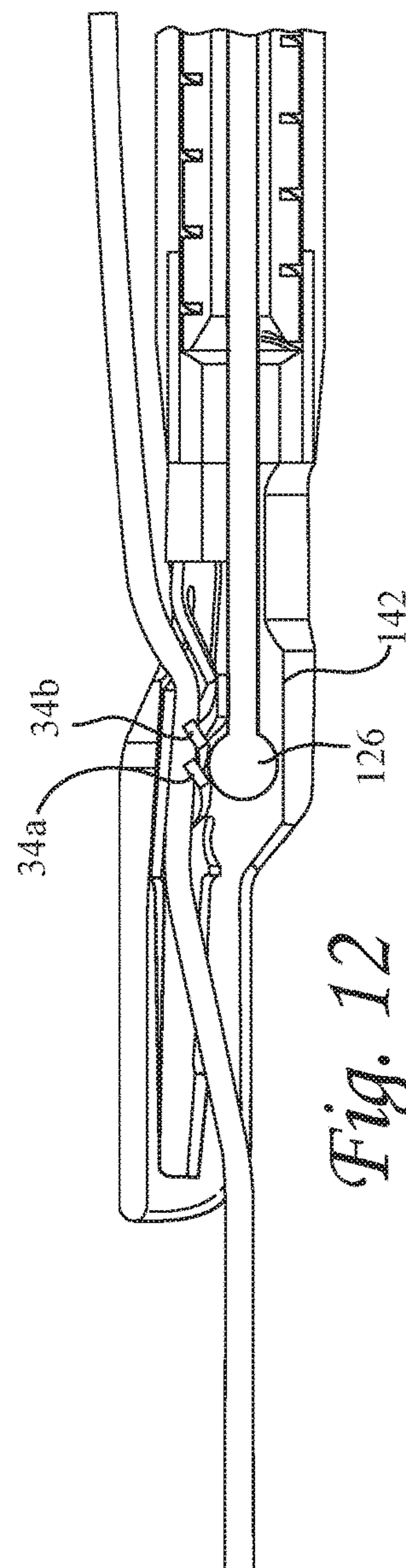
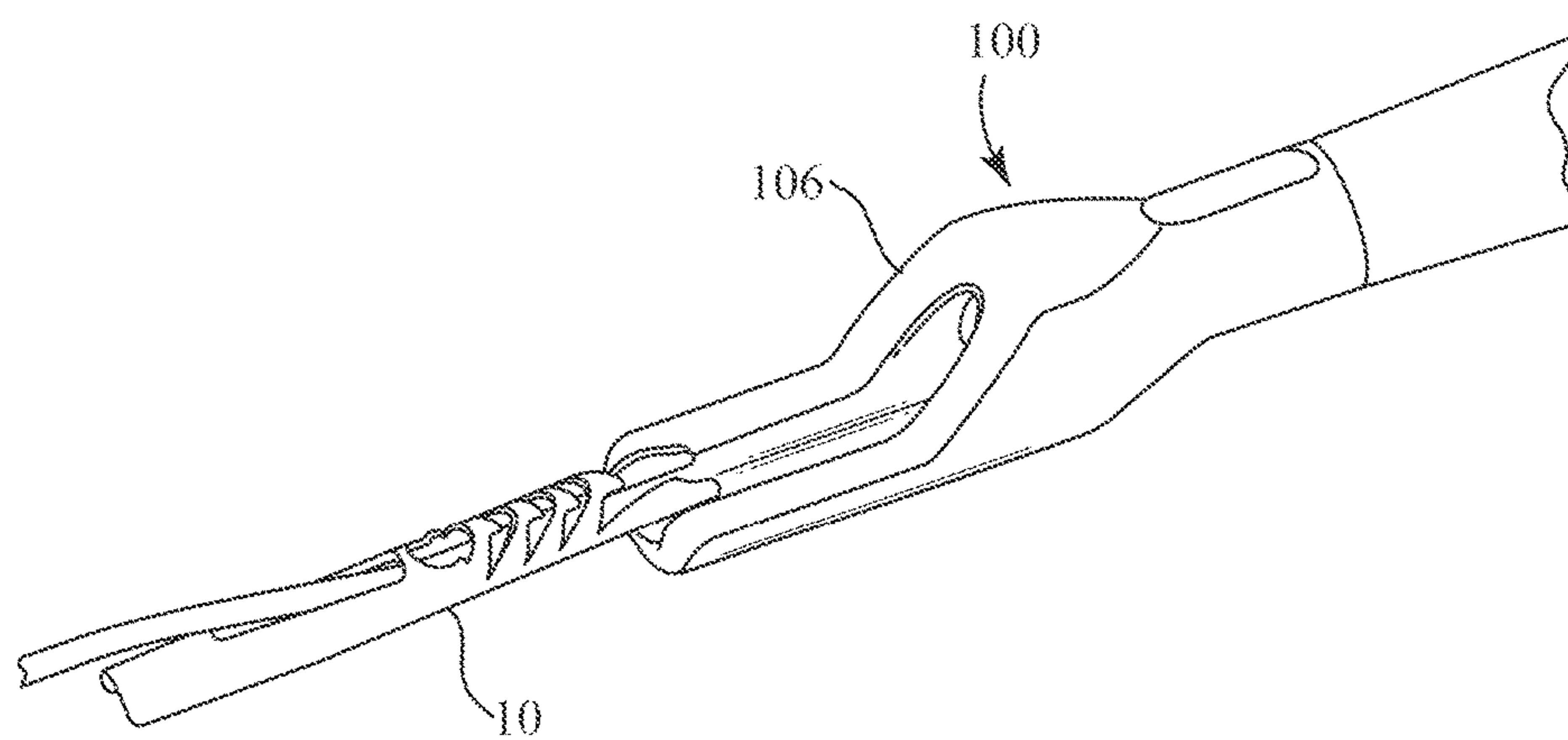
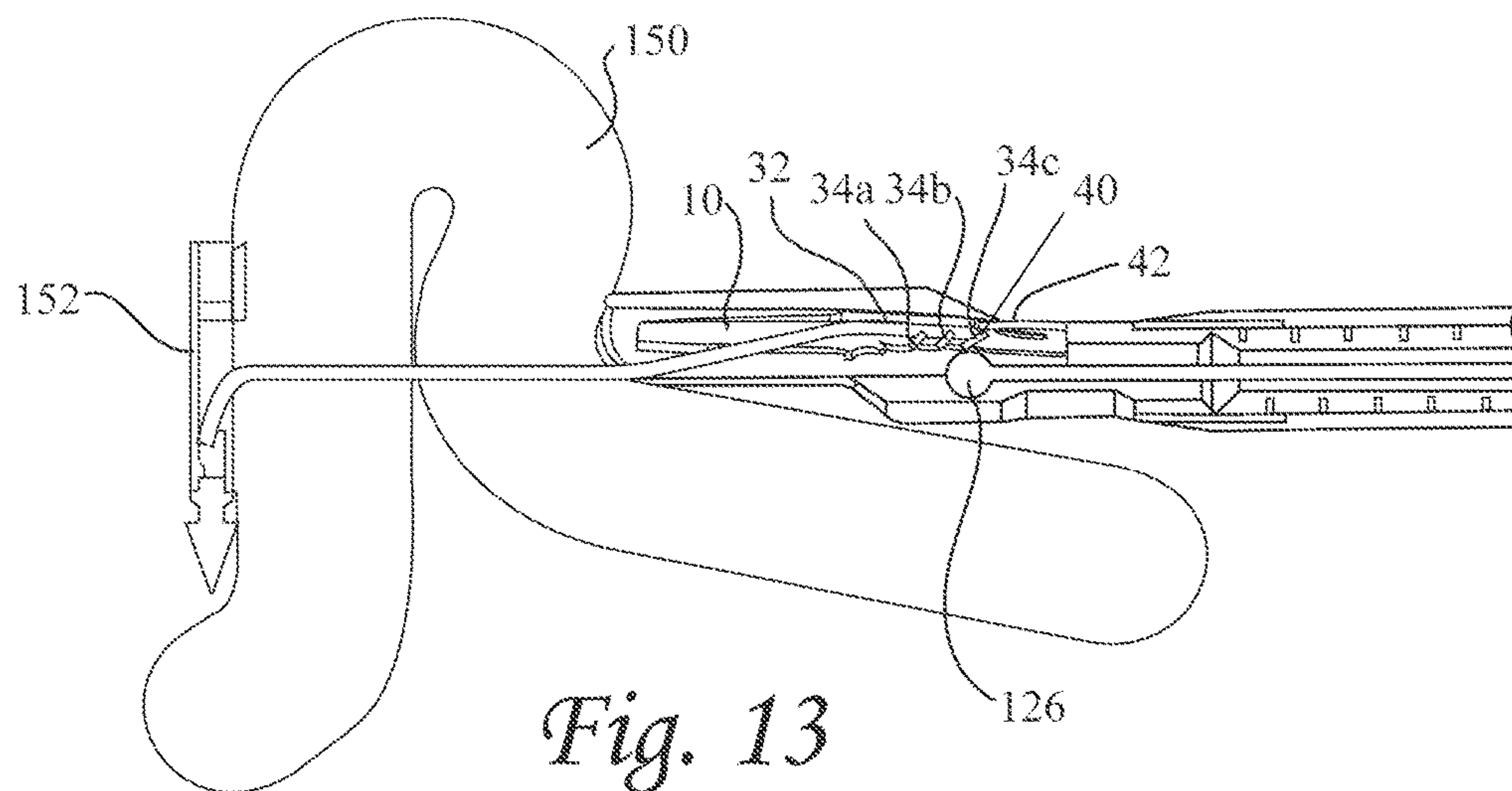
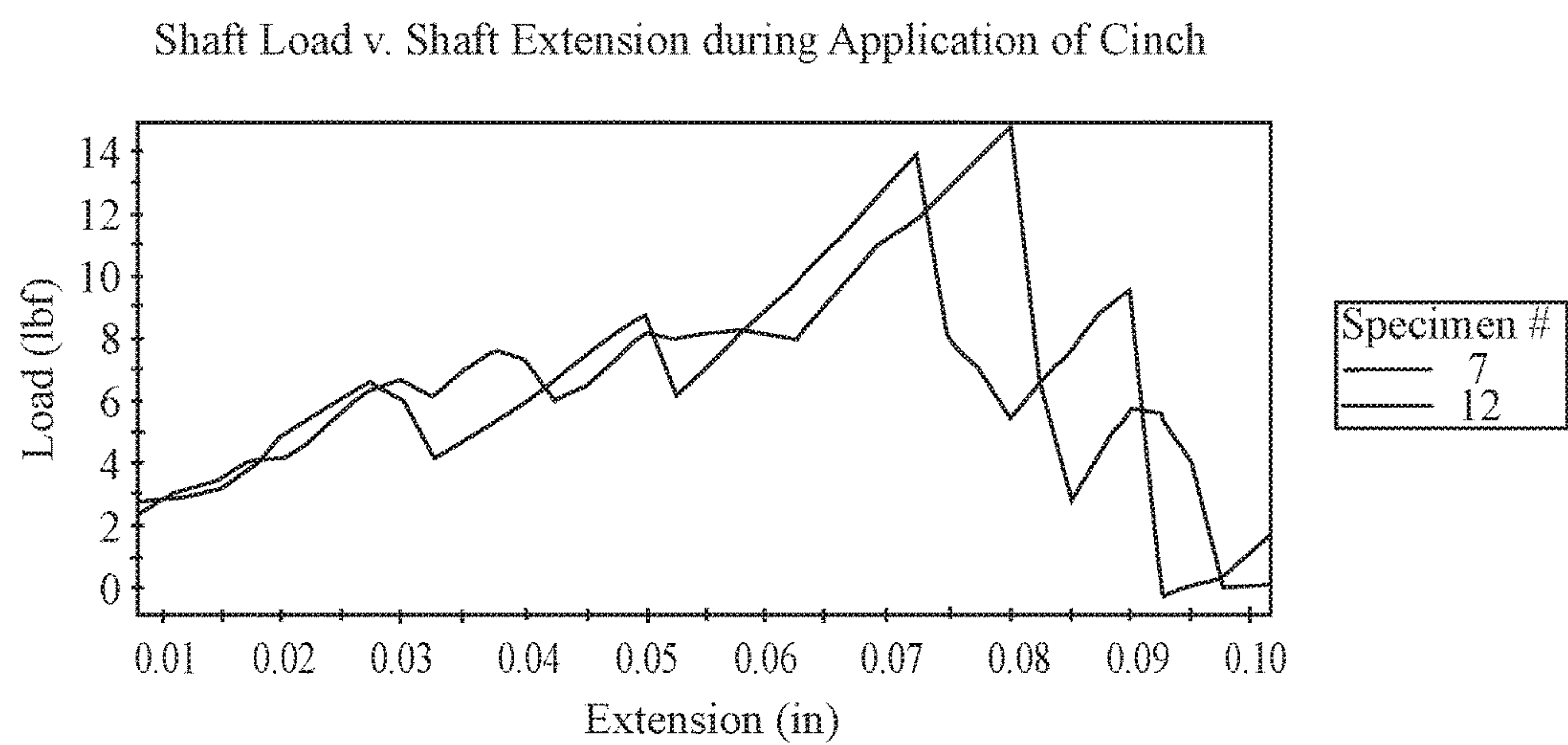
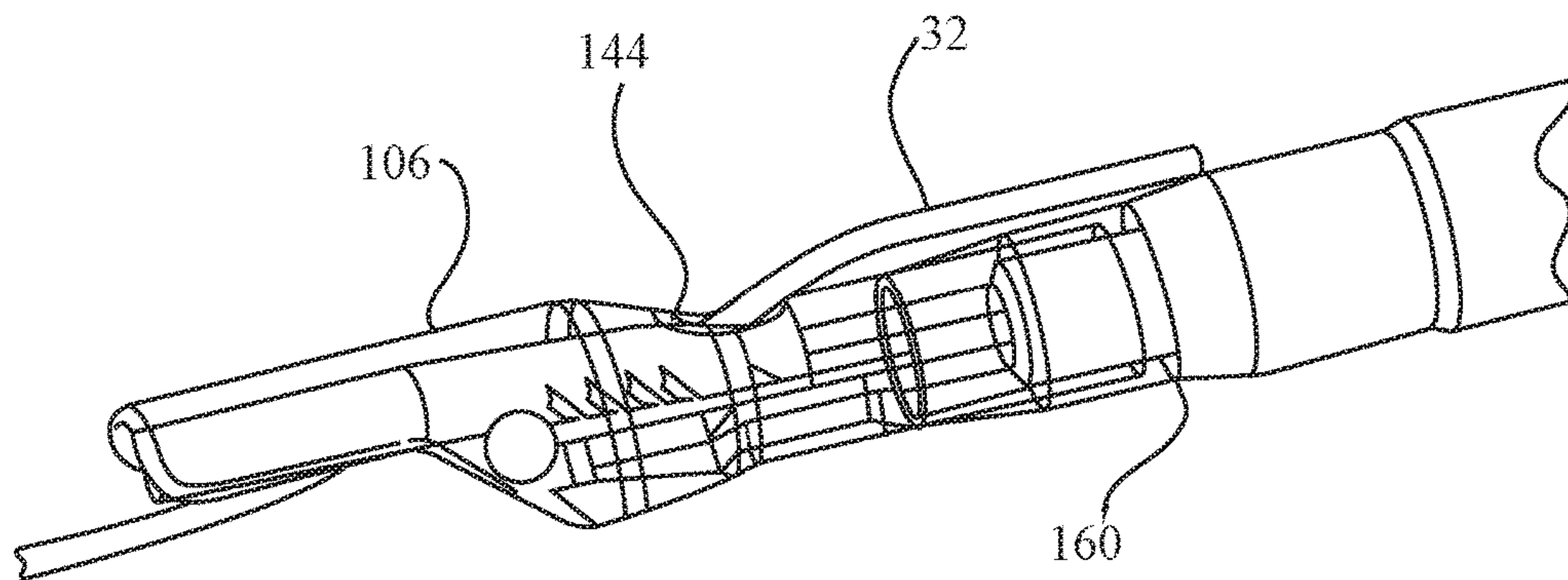


Fig. 12

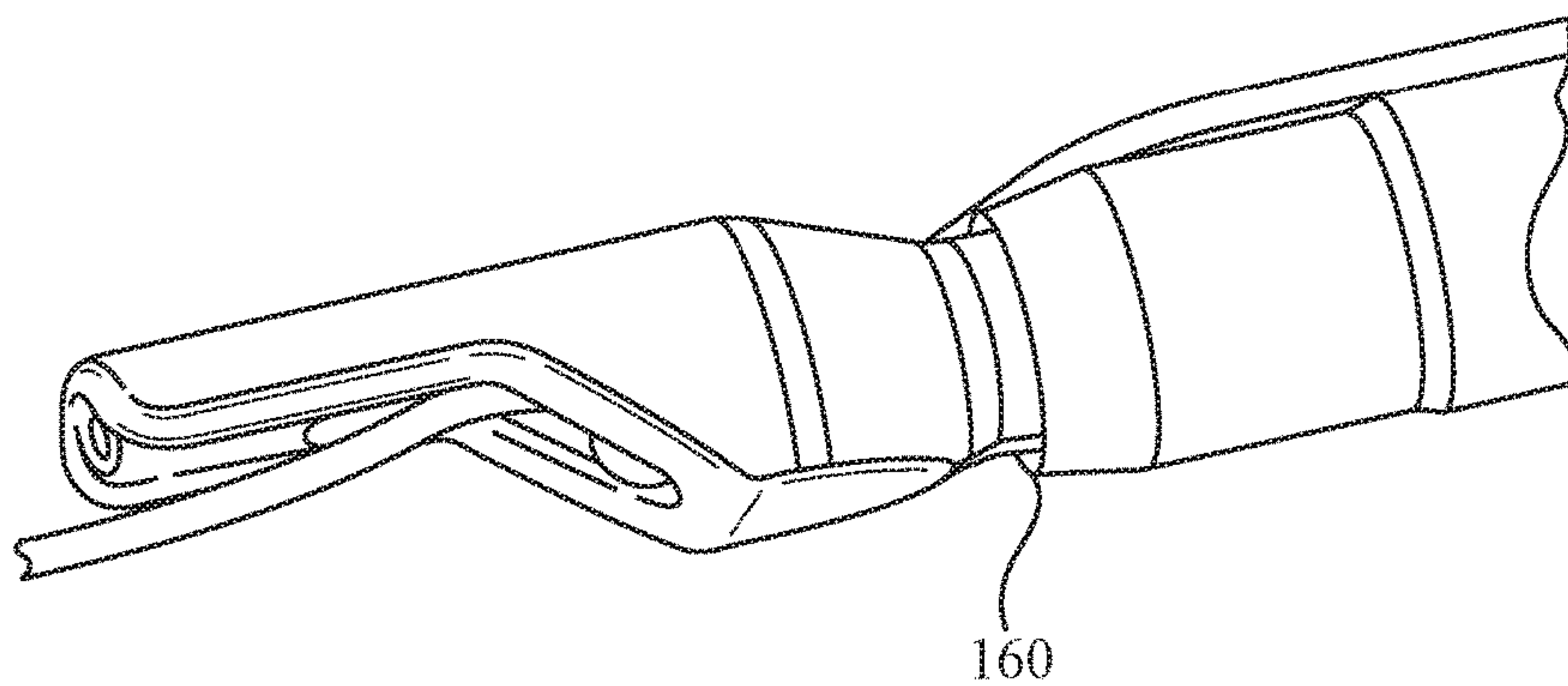




*Fig. 15*



*Fig. 16*



*Fig. 17*

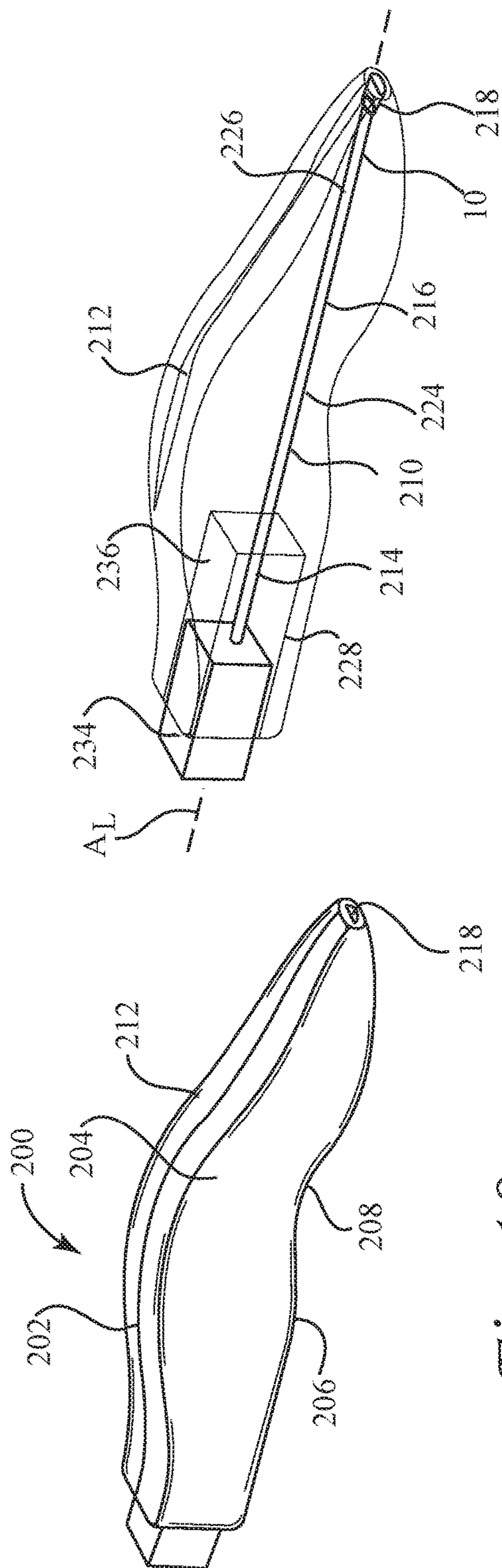


Fig. 18

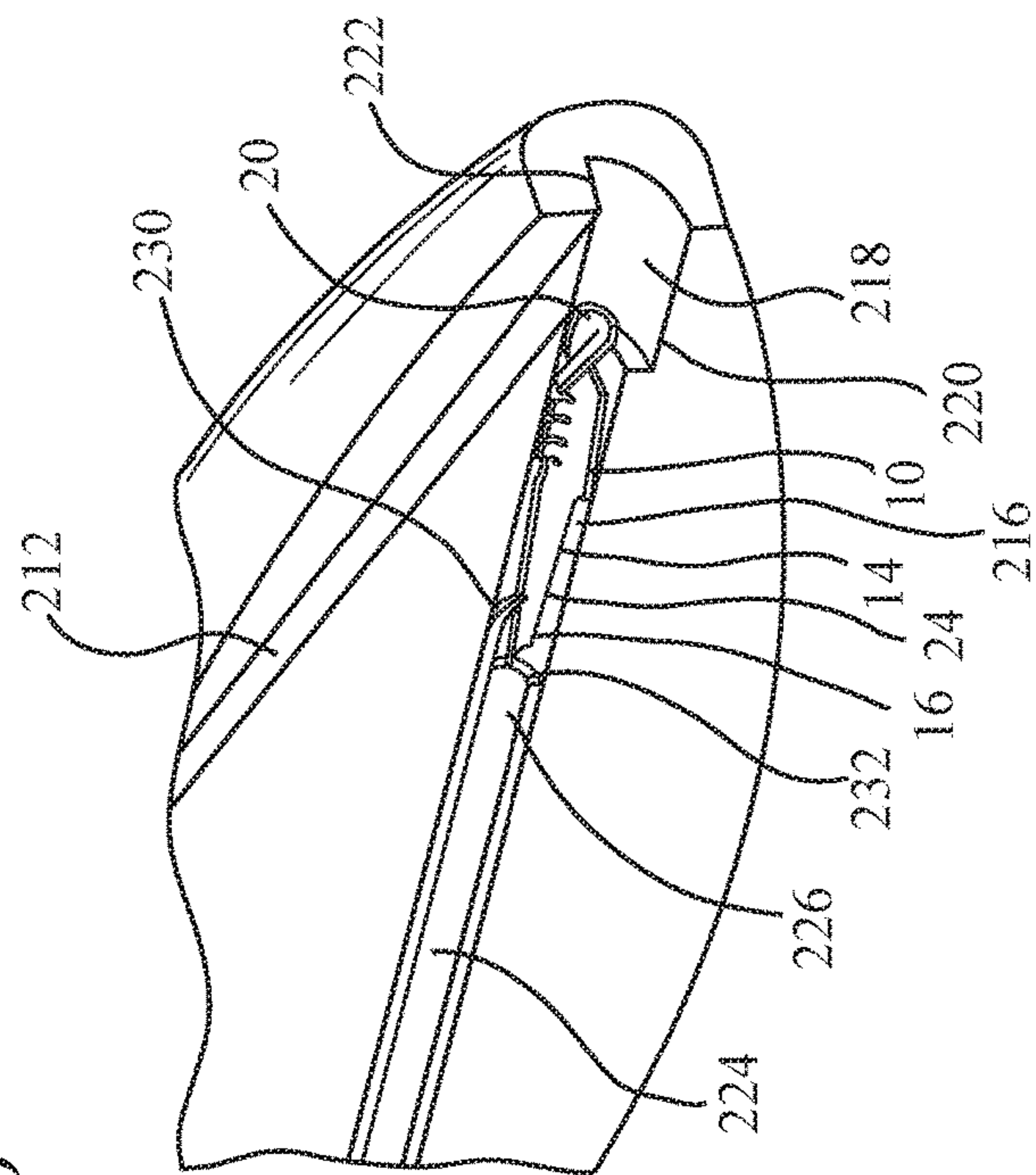


Fig. 20



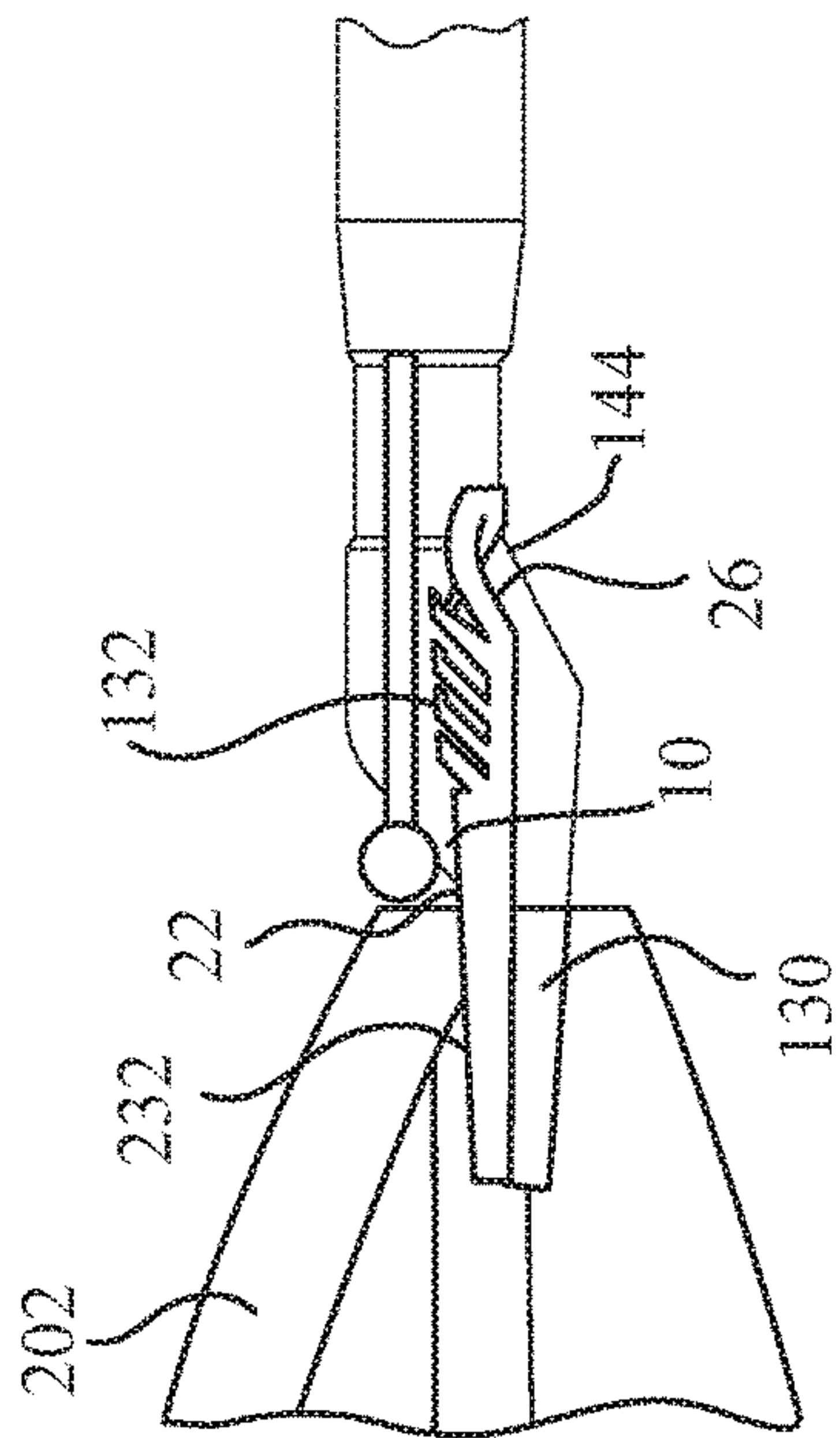


Fig. 22

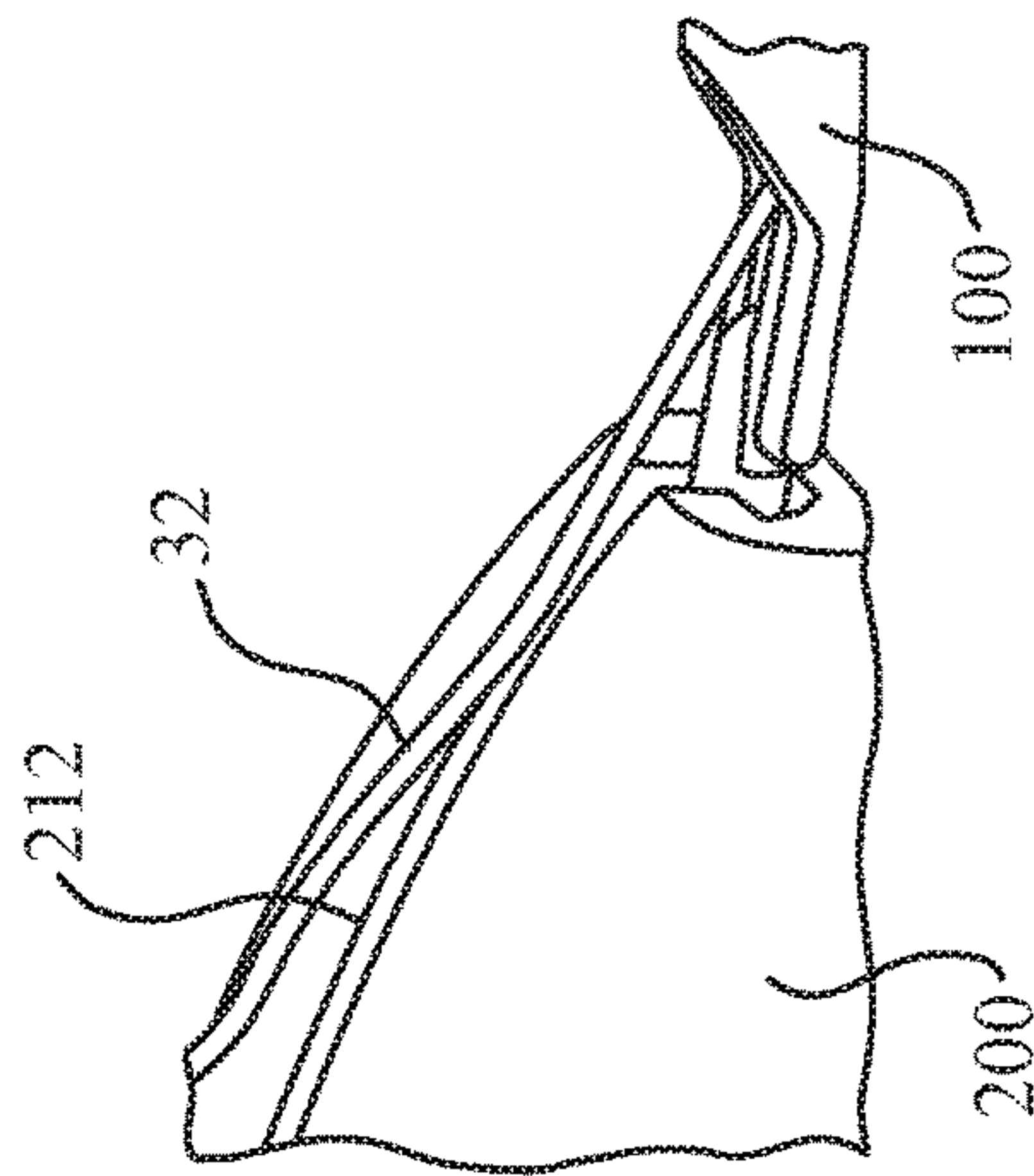


Fig. 24

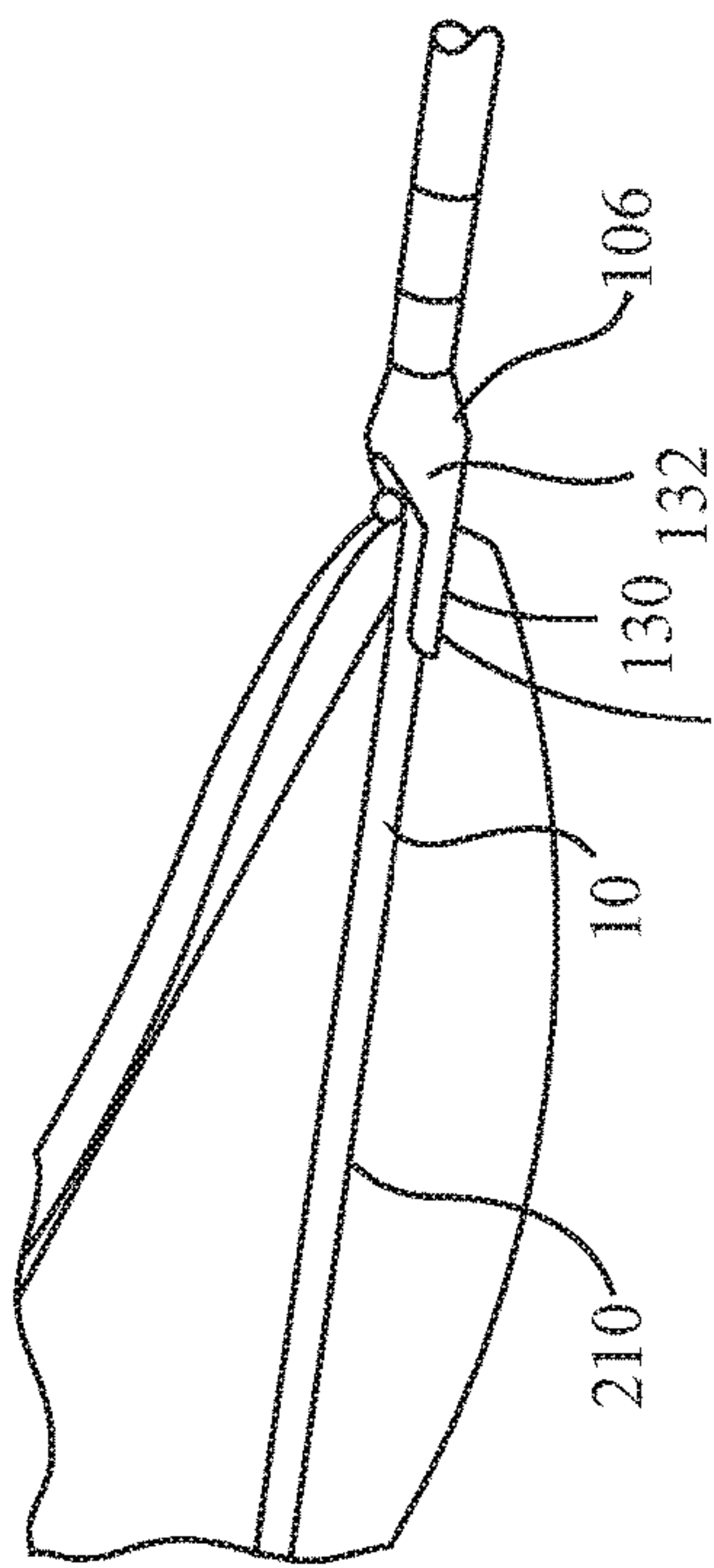


Fig. 21

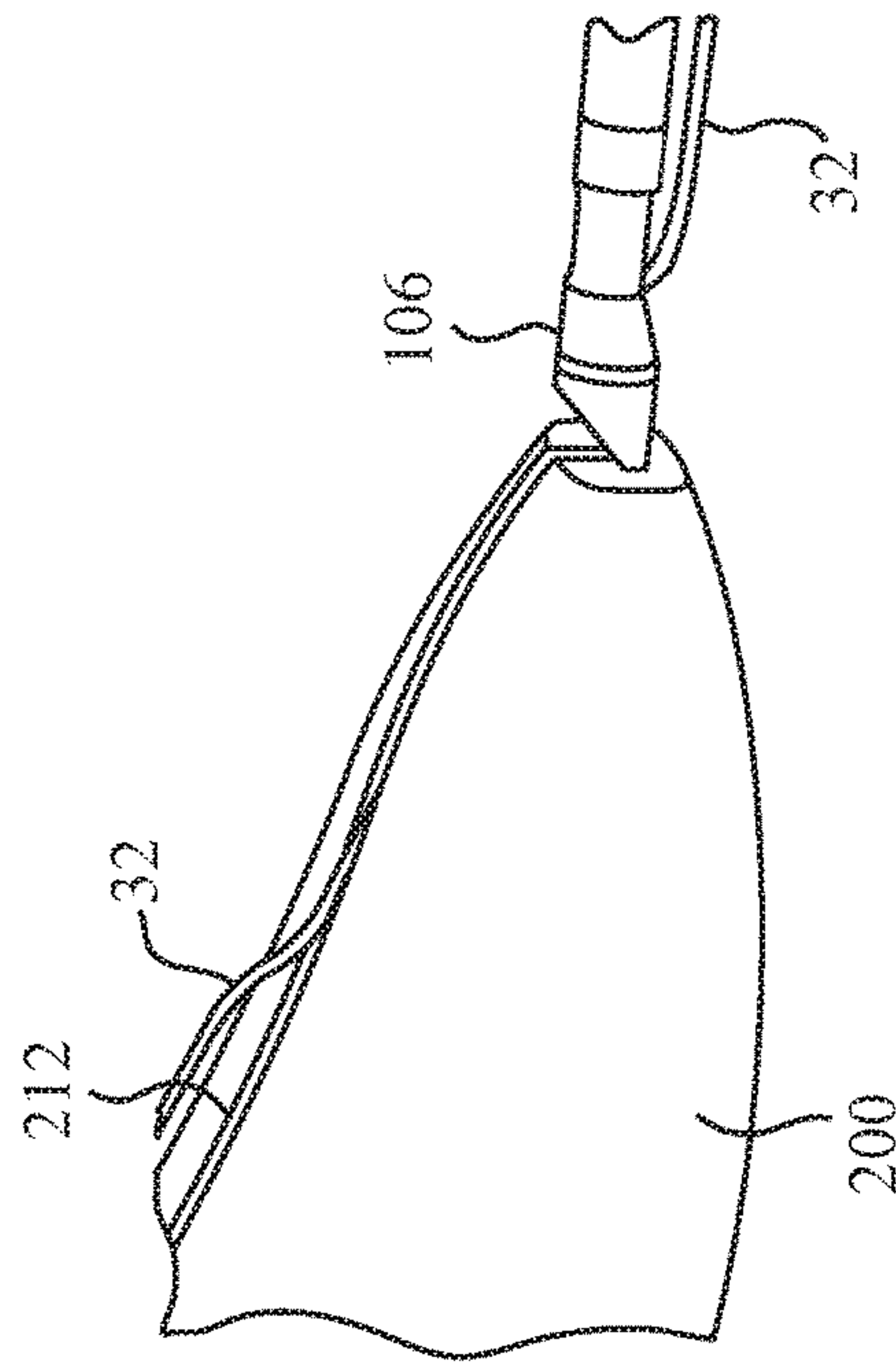


Fig. 23



## ENDOSCOPIC SUTURE CINCH

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Ser. No. 14/206,098, filed Mar. 12, 2014, which claims benefit of U.S. Provisional App. No. 61/777,607, filed Mar. 12, 2013, which are hereby incorporated by reference herein in their entireties.

## BACKGROUND OF THE INVENTION

## Field of the Invention

The present invention relates to a device that can be inserted into a body through a natural orifice with an endoscope or other steerable guide member. The present invention may be used in conjunction with a suturing instrument to secure an applied suture to the tissue of a mammal, whether human or not, and whether or not alive.

## State of the Art

Natural orifice surgery involves passing surgical instruments in association with an endoscopic camera through a natural orifice, such as the mouth, vagina, or anus, to a desired organ. By avoiding major incisions through the skin, muscle, and nerves of the abdomen, patients may experience a quicker recovery with less pain and scarring while further reducing the post-operative risk of surgery.

In co-owned US Pub. Nos. 20090312775A1 and 20120157765, endoscopic suturing devices suitable for use in a natural orifice procedure are described. The devices described each have a structure with a sufficiently small distal profile for delivery through a natural orifice, while providing a needle movable on an arm through a large opening and closing angle and which produces a large force upon the needle for piercing tissue to perform a surgical operation such as tissue approximation and suturing. A length of suture is permanently attached to the needle and forms stitches about tissue engaged at the distal end of the device as the needle is moved through the tissue and the distal end of the device is moved relative to the tissue. After one or more stitches have been formed in the tissue, the needle is released from the device and the free end of the suture is secured relative to the tissue. In accord with one manner of securing the free end of the suture, portions of the suture may be tied together about the tissue. In accord with another manner of securing the suture, a cinch element is advanced over the suture and cinches the tissue between the needle on one side of the tissue and the cinch on the other side of the tissue.

In addition to the cinch and cinch-applying instrument described in the above-referenced publication, other cinch instruments and deployable cinches are known. For example, referring to prior art FIG. 1, also known is a cinch applicator 910 for use in deploying the two parts 912, 914 of a cinch onto suture 916 in a surgical procedure. The applicator 910 includes an elongate flexible tubular member 918, a hypotube 920 fixed to the distal end 922 of the flexible tubular member 918, a flexible shaft 924 extending through the tubular member 918 and the hypotube 920, and a proximal handle (not shown) for moving the shaft 924 longitudinally relative to the tubular member 918. The hypotube 920 defines a distal housing 926 and a proximal lateral window 928. A slidable plunger 930 formed with a guillotine 932 is provided within the hypotube 920, with the guillotine 932 fully proximal of the housing 926 and distal of the lateral window 928.

The two-part cinch includes a collar 912, and a plug 914 engageable within the collar. The collar 912 has a cylindrical outer shape that is retained in the distal housing 926 of the hypotube 920 with a simple dimpling mating structure. The collar 912 also includes a proximal inner lip 933, and an outer lip 934 seating at the distal end of the hypotube 920 and having a flat distal facing end 935. The plug 914 of the cinch is attached to the distal end of the flexible shaft 924. The plug 914 has an enlarged distal flange 936 corresponding in size and shape to the outer lip 934 on the collar 912. The plug 914 has an elongate tubular body 938 defining a throughbore 940 in which the flexible shaft 924 extends, and a proximal circumferential exterior groove 942. A distal portion of the shaft 924 has a bend 944 to facilitate retention within the throughbore 940. The distal end of the shaft 924 has a rounded bead 946 that sits at the flange 936 of the plug. The bend 944 and the bead 946 trap the flexible shaft relative to the plug.

In operation, from outside the patient, the proximal end of the suture 916 is thread through the collar 912 and hypotube 920 and out of the lateral window 928. Then the applicator 910 is advanced through an endoscope so that the elements of the cinch are provided adjacent the stitched tissue. When the handle is operated, the shaft 924 is retracted to draw the plug 914 into an interference fit within the collar 912, with the inner lip 933 of the collar positively engaging the outer groove 942 on the plug. The suture 916 is captured between the outer surface of the plug 914 and the inner surface of the collar 912 so that the cinch is secured to the suture. Upon further retraction of the shaft 924, the shaft is pulled such that the bend 944 and bead 946 of the shaft 924 are pulled all the way through the plug 914 until released therefrom, and drawn back into engagement with the plunger 930. As the shaft 924 is moved further proximally relative to the hypotube 920, movement of the shaft 924 causes the guillotine 932 to slide past the window 928 and sever the proximal portion of the suture 916 from the portion of the suture attached to the cinch. Once the suture 916 is severed, a jerking motion is applied to the applicator 910 to release the engagement formed by the dimpling structure between to the cinch 912, 914 and applicator 910.

The applicator and cinch are thereby together capable of effectively securing stitched suture to tissue. Once the cinch 912, 914 is secured to the suture, the applicator 910 is no longer capable of securing another cinch on another area of suture, as the bend 944 and bead 946 of the shaft 924 cannot be inserted through another plug during the procedure; the shaft is intended to be proximally loaded through the plug. Thus, the applicator is a single-use device.

## SUMMARY OF THE INVENTION

In accord with the invention, a suture cinch, cinch applicator, and cinch loader for loading the cinch into the cinch applicator are provided and permit re-use of the applicator with multiple suture cinches during an endoscopic surgical procedure. The cinch applicator can be loaded with a first cinch, apply the first cinch onto a portion of suture to fix the portion of suture relative to anatomical tissue, reloaded with a second cinch using the loader, and subsequently used to apply the second cinch to fix another portion of suture to fix the other portion of suture relative to anatomical tissue. The process can be repeated to apply additional cinches on suture as required during a procedure.

The cinch is a tubular member having a periphery, a longitudinal axis, a first portion defining a first end of the tubular member, and a second portion longitudinally oppo-



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site the first portion defining a second end of the tubular member. An entry opening is provided in a first side of the periphery at the first portion, and an exit opening is provided in a second side of the periphery at the second portion, with the first and second sides being located on opposing sides of the periphery such that the entry and exit openings face in opposite directions. A suture pathway extends from the entry opening to the exit opening. At least one plastically deformable rib extends partially about the periphery of the tubular member transverse to the longitudinal axis. A seat is provided in the first side of the periphery between the entry opening and the rib for receiving a force-applying member of the applicator, discussed below. The cinch may optionally define a deformable cutter. In preferred embodiments, the cinch is of the generally small size required to accommodate securing a single strand of suture dimensioned for securing two portions of soft tissue together.

The applicator includes a handle having first and second relatively displaceable handle members. An elongate flexible tubular member is coupled to the first handle member, and a rigid cinch housing for retaining the cinch during use is fixed at the distal end of the tubular member. A flexible shaft is coupled to the second handle member, and terminates in a force-applying member, preferably in the form of a bead.

According to a preferred embodiment, the cinch housing includes a socket in which the cinch is received. The distal end of the housing is partially tubular, providing lateral access to the entry opening in the cinch, and has a support wall for the cinch that preferably extends parallel to the longitudinal axis of the tubular member. A central portion of the socket tapers in diameter in a distal to proximal direction. When the cinch is seated in the socket, the force-applying member is seated in the seat of the cinch and slight retraction on the shaft operates to retain the cinch in the housing. However, the bead cannot be readily further retracted, as the housing tapers in diameter and the ribs block passage of the bead. The proximal portion of the housing includes a window for alignment with the exit opening of the cinch and through which suture may be passed.

With the handle in a first position, the bead is located distal of said distal opening of the cinch housing allowing loading of a cinch into the socket of the housing. When the handle is in a second position, the bead engages within the seat of the cinch and enters the socket to retain the cinch in the housing. In accord with the invention, when a sufficient force is applied at the handle to move the handle from the second position into a third position, the bead is forcibly drawn along the cinch against the ribs of the cinch to sequentially deform the ribs of the cinch against the suture and onto the suture and thereby lock the cinch onto the suture.

In accord with another aspect to the invention, the cinch includes an integral tab that extends at an oblique angle relative to the longitudinal axis of the cinch to define a guide that deflects suture advanced through the tubular member toward and through the exit opening.

In accord with a further aspect of the invention, the cinch includes an integral tab that is deformed by movement of the bead along the cinch to deform the tab against the suture extending within the pathway to cut the suture. The tab that deflects suture is preferably the same tab that cuts the suture.

Also in accord with the invention, the cinch is a unitary single-part device, preferably constructed from a metal

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hypotube, and which is laser cut to define the entry and exit openings, the ribs, and the suture deflecting, suture cutting tab.

In accord with another preferred aspect of the invention, the cinch is loaded within the cinch housing such that the ribs are oriented at an oblique angle relative to the longitudinal axis of the tubular member, and consequently at an oblique angle relative to the displacement axis of the shaft. Therefore, when the handle is operated to move the bead from the first position to the third position, the bead is proximally retracted in a linear manner, but an angle and relative to the ribs. This facilitates deformation of the ribs against the suture. Where the cinch defines a suture cutter, as the bead is drawn proximally along the cinch, the bead displaces the suture cutter to cause it to cut the suture.

In accord with another aspect of the invention, in an embodiment in which the cinch does not define an integrated cutter, the cinch applicator is provided with suitable means to cut the suture after the cinch is secured on the suture. By way of example only, such means includes a cutter that can be moved relative to the window in the housing in a relatively longitudinal or rotational manner, or a punch that is sufficiently movable through the window to sever the suture extending through the window from the suture attached to the cinch and tissue. Once the shaft is fully retracted into the third position by operation of the handle and the suture is cut, the bead is located proximal of the ribs and any suture deflecting/cutter tab, thereby allowing retraction of the entire applicator relative to cinch and release of the cinch from the cinch housing. The applicator is then withdrawn from the body of the patient.

In accord with another aspect of the invention, a loader is provided to load a suture cinch into the applicator. This is advantageous as the cinch is particularly small, thereby rendering it somewhat impractical for manipulation into the proper orientation into the housing by the fingers of an operator. The loader can be provided preloaded with a cinch or can be operator-loaded with a cinch, as the operation is easier than loading the housing. The loader includes a cinch recess in which to receive the cinch, and a cinch pusher displaceable relative to the recess. The distal end of the pusher has a tip with a first portion shaped to engage the lateral entry opening in the cinch to retain the cinch, and a second portion that butts against the first end of the cinch such that it can apply a pushing force thereagainst. The proximal end of the recess is enlarged in size and shaped to accommodate receiving the distal end of the cinch housing. When the housing is pushed in the enlarged proximal recess, the pusher is activated to load the cinch into the socket. The loader also includes a suture guide slot to facilitate guiding suture into the lateral entry opening of the cinch after the cinch is loaded into the socket.

The described system has particular use in endoscopic procedures in a NOTES procedure in which an endoscopic stitching instrument has applied one or more stitches of suture through tissue, in a procedure on gastrointestinal tissue where it is necessary or desirable to secure one or more sutures, or in any other endoscopic procedure where it is necessary or desirable to secure one or more sutures. In a mode of such stitching, a needle fixed to one of the suture is advanced through the tissue and carries the suture through the tissue. Once the tissue is sufficiently stitched to approximate the tissue, the cinch applicator with cinch is provided for cinching the suture against the tissue and/or relative to the suture needle. Subsequently, the cinch applicator may be withdrawn from the patient, a new cinch may be loaded into the cinch housing, preferably through use of the cinch



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loader, and the cinch applicator can be used again to secure an addition suture. The process may be repeated as necessary.

Additional objects and advantages of the invention will become apparent to those skilled in the art upon reference to the detailed description taken in conjunction with the provided figures.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial section of a distal end of a prior art endoscopic cinch applicator and a prior art two-part cinch.

FIG. 2 is a perspective view of a first embodiment of a suture cinch according to the invention.

FIG. 3 is a first side view of the suture cinch.

FIG. 4 is a longitudinal section view of the suture cinch taken across line 4-4 in FIG. 3.

FIG. 5 is a second side view of the suture cinch.

FIG. 6 is a side elevation view of the suture cinch with the cinch in the same orientation as FIG. 4, with suture extending through the cinch.

FIG. 7 is a view similar to FIG. 4, with suture extending through the cinch.

FIG. 8 is view similar to FIG. 7, but with the cutter tab displaced to cut suture extending through the exit opening.

FIG. 9 is a perspective view of the cinch applicator.

FIG. 10 is a longitudinal section view of the distal end of the cinch applicator loaded with a cinch.

FIGS. 11 and 12 are views similar to FIG. 10, with the bead of the cinch applicator shown displaced across the ribs of the cinch.

FIG. 13 is a longitudinal section view showing final cinching of the cinch onto suture at tissue.

FIG. 14 is a broken distal end perspective view illustrating release of the cinch from the cinch applicator.

FIG. 15 is a graph of the load required to the deform the cinch on the suture.

FIGS. 16 and 17 are broken distal end perspective views illustrating a cutting feature of the cinch applicator.

FIG. 18 is a perspective view of a cinch loader.

FIG. 19 is a transparent perspective view of the cinch loader of FIG. 18.

FIG. 20 is a broken longitudinal section view of the proximal end of the cinch loader.

FIG. 21 is a partially transparent perspective view of the distal end of the cinch applicator coupled to the cinch loader.

FIG. 22 is a transparent side elevation view of the distal end of the cinch applicator coupled to the cinch loader, illustrating loading of a cinch into the cinch housing.

FIG. 23 is a perspective view of the distal end of the cinch applicator coupled to the cinch loader, illustrating advancing suture through the cinch loader and into the cinch applicator.

FIG. 24 is a perspective view of the distal end of the cinch applicator coupled to the cinch loader, illustrating removal of the suture relative to the cinch loader.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In accord with the invention, a suture cinch 10 (FIGS. 2 through 8), a cinch applicator 100 (FIGS. 9 through 17), and cinch loader 200 for loading the cinch 10 into the cinch applicator 100 (FIGS. 18 through 24) are provided and permit re-use of the applicator with multiple suture cinches during an endoscopic surgical procedure.

In accord with a method of the invention, described further below, the cinch applicator can be loaded with a first

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cinch, apply the first cinch onto a portion of suture to fix the portion of suture relative to anatomical tissue, reloaded with a second cinch, and subsequently used to apply the second cinch to fix another portion of suture to fix the other portion of suture relative to anatomical tissue. Loading and reloading of the applicator with cinches is facilitated with the cinch loader. The process can be repeated to apply additional cinches on suture as required during a procedure.

Turning now to FIGS. 2 through 5, the cinch 10 is a unitary tubular element preferably formed from a portion of a metal hypotube, such as a stainless steel tube, and is preferably laser cut to define the features thereof in a unitary construct. Alternatively, the tubular element can be made from a plastic, including a bioresorbable material, and can also be machined or molded to define the features thereof, as now described. The tubular element has a round periphery 12 defining a circumference, a longitudinal central axis  $A_L$ , a first portion 14 defining a first end 16 of the tubular element, and a second portion 18 longitudinally opposite the first portion and defining a second end 20 of the tubular element. An elongate entry opening 22 is provided in a first lateral (hemi-tubular) side 24 of a periphery 12 (i.e., extending a first 180° about the axis  $A_C$ ) at the first portion 14, and an exit opening 26 is provided in a second lateral (hemi-tubular) side 28 of the periphery (i.e., extending an opposite second 180° about the axis  $A_C$ ) at the second portion 18, with the first and second hemi-tubular sides 24, 28 being located on opposing sides of the periphery 12 such that the entry and exit openings 22, 26 face in opposite directions. The entry opening 22 preferably expands in lateral dimension in a direction defined from the first end toward the second end. A suture pathway 30 extends from the entry opening 22 to the exit opening 26, generally parallel to the longitudinal axis  $A_L$ . Referring to FIGS. 6 and 7, the cinch 10 and pathway 30 are of the generally small size required to accommodate receiving and securing a single strand of suture 32 dimensioned for coupling two portions of soft tissue together. By way of example only, the cinch 10 has a length of 4 to 15 mm and a maximum diameter of 0.5 to 1.5 mm.

Referring back to FIGS. 4 and 5, at least one plastically deformable rib, collectively 34 (with three ribs 34a, 34b, 34c shown in the illustrated embodiment), is provided along the first side 24 of the second portion 18 of the tubular element and extends partially about the periphery of the tubular element to the longitudinal axis  $A_C$ . The ribs 34 are formed and separated by preferably laser cut slots that extend into the tubular element at an oblique angle relative to the longitudinal axis, such that the ribs 34 are also oriented at a like angle. As a result, each of the ribs 34 has a leading end 36 oriented toward the second end 20 of the tubular element, and a trailing end 38 angled back toward the first end 16 of the tubular element; i.e., the ribs are obliquely angled relative to the axis  $A_C$  from the first end 16 toward the second end 20. The slot is formed such that the leading end is defined by a curvilinear cut and the trailing end is defined by a straight cut. This results in a defined weakness in the rib 34 such that the rib has a tendency to fold over into securement with suture when subject to a force, as described below. That is, the ribs 34 are formed such that when subject to the force of the applicator as described below, the ribs will twist and extend transversely into the suture pathway. The last of the ribs preferably includes a tongue-like projection 40.

Referring to FIGS. 3, 4, and 7, an optional tab 42 is defined at the exit opening 26, extending from adjacent the second end 20 at the second side 24 of the second portion 18



of the tubular element and deflected radially inward into the interior of the tubular element. The tab **42** is adapted to deflect and guide suture **32** advanced through the pathway **30** (from the entry opening **22**) toward said exit hole **26**. The tab **42** is provided with several longitudinal slits **44** to reduce its bending stiffness. As described in more detail below, the tab **42** is adapted to be bent by the tongue-like projection **40** on the last rib **34c** and displaced toward the exit hole **26** by operation of the applicator, such that it cuts suture extending between the pathway **30** and exit hole **26**, as shown in FIG. **8**.

Referring to FIGS. **4** and **5**, an opening in the first side of the tubular element between the entry opening **26** and the ribs **34** defines a seat **46** for receiving a force-applying member of the applicator. The seat **46** preferably has a generally horseshoe-shape, formed opposite of a first **34a** of the ribs.

Referring to FIGS. **1** through **3**, the first side **24** of the tubular element is preferably substantially straight from the first end **16** to the second end **20**. The second side **26** of the first portion **14** of the cinch, from the first end **16** and along the length of the entry opening **22**, is canted relative to the second side of the second portion **18**. This is preferably structured by cutting into the periphery of the second side of the first portion at **48** along an oblique angle relative to the longitudinal axis to open the periphery thereat. The oblique angle of the cut is preferably  $9^{\circ}$  to  $11^{\circ}$ . As discussed below, this shape facilitates providing the cinch in a preferred orientation within the applicator such that the applicator can apply an optimal deformation force to deform the ribs and cutter tab.

With reference to the following description of the applicator, the terms “proximal” and “distal” are defined in reference to the hand of a user of the device, with the term “proximal” being closer to the user’s hand and generally at a ‘handle’ end of an instrument, and the term “distal” being further from the user’s hand, and generally at an operative end of an instrument such as to often be located further within a body of the patient during use.

Turning now FIG. **9**, the applicator **100** includes a proximal handle **102**, a flexible tubular member **104**, a rigid cinch housing **106** located at the distal end **108** of the tubular member and adapted for retaining the cinch **10** during use of the applicator, and a flexible shaft **110**. The proximal handle **102** has first and second relatively displaceable handle members **112**, **114** for moving the shaft **110** relative to the cinch housing **106**.

Referring to FIG. **10**, the flexible tubular member **104** has a longitudinal axis along which the shaft **110** extends, and comprises a preferably flat wound coil **116** surrounded by a lubricious polymer sheath **118**. The flexible tubular member **110** preferably has a sufficiently small diameter and sufficient length to extend completely through the working channel of an endoscope, but may be used outside the endoscope. Suitable dimensions for use within a working channel of an endoscope include an outer diameter of 2.0 to 2.2 mm and a length of 190 to 300 cm. In addition, the tubular member **110** is sufficiently flexible to be advanced through a tortuous path; i.e., to extend through the working channel of a retroflexed endoscope—one that is bent through an arc of  $180^{\circ}$ . The tubular member **110** includes a proximal end **120** coupled to the first handle member **112**.

The flexible shaft **110** includes a proximal end **122** coupled to the second handle member **114**, and a distal end **124** terminating in a bead **126**, preferably in the form of a sphere. The bead **126** is preferably unitarily integrated at the distal end of the shaft. The bead **126** can take alternative

forms from spherical including, but not limited to, oblong and pyramidal. In all forms, the bead **126** preferably tapers toward its proximal end where it joins to or is otherwise coupled to the distal end **124** of the shaft **110**. Further, the bead **126** may comprise a discrete structure from the shaft. Whether unitary with or discrete therefrom, the bead may be coupled to the distal end of the shaft by any suitable means including, by way of example, solder, braze, or a bonding agent, a pin, or an articulating link.

According to a preferred embodiment, the cinch housing **106** is crimped, welded, or otherwise fixed to the distal end **108** of the tubular member **104**. The cinch housing **106** defines a distal longitudinal hood **130** and a central socket **132** in which the cinch **10** is received. The hood **130** partially surrounds the cinch **10**, protecting the distal portion **14** of the cinch from the tissue during use. The hood **130** has a curved first surface **134** and a flat second surface **136**. The flat surface **136** defines a groove **138** that co-extends into the socket **132**. The groove **138** is laterally open, thereby providing lateral access to the entry opening **22** of the cinch **10**. The groove **138** preferably extends parallel to the longitudinal axis  $A_T$  of the tubular member **104** for support of the angled second side (at cutout **48**) of the first portion **14** of the cinch **10**. The socket **132** tapers in diameter in a distal-to-proximal direction. The taper of the socket is preferably defined by a canted wall **140** extending proximally from the hood **130** and oriented obliquely relative to the longitudinal axis  $A_T$  of the tubular member **104** and an opposing axial wall **142** oriented parallel to the longitudinal axis of the tubular member. The canted wall **140** and axial wall **142** are preferably angled at approximately  $9^{\circ}$  to  $11^{\circ}$  relative to each other. The proximal portion of the housing includes a window **144** that aligns with the exit opening **126** of a loaded cinch **10** and through which suture **32** may be passed. The cinch housing **106** preferably has a maximum length of 25 mm and a maximum outer diameter of 2.6 mm such that it can be advanced through a 2.8 to 3.2 mm working channel of an endoscope.

Referring to FIGS. **9** and **10**, with the handle **102** in a first position (e.g., with the second handle member **114** in its most distal location relative to the first handle member **112**), the bead **126** is located distal of the socket **132** of the cinch housing allowing loading of a cinch **10** into the socket of the housing. The cinch **10** is loaded such that the ribs **34** sit at an oblique angle relative to the axial wall **142**, and consequently at an oblique angle relative to the displacement axis of the shaft **110** once the shaft is drawn into retraction parallel to the longitudinal axis  $A_T$  of the tubular member **110**.

Then, when the handle **102** is in a second position (with the second handle member in a relatively proximal location relative to the first position), the bead **126** engages within the seat **46** of the cinch and at least partially enters the socket **132** to retain the cinch **10** in the housing **106** (the configuration specifically shown in FIG. **10**). The shaft **110** with bead **126** cannot be readily further retracted, as the space between the axial wall **142** of the socket **132** and the ribs **34** of the cinch **10** is too small, and blocks passage of the bead.

In either the first or second handle positions, the suture **32** can be advanced into the entry opening **22**, through the pathway **30**, and out the exit opening **26** of the cinch, and out the window **144** of the housing. Once the suture **32** is threaded through the cinch (and therefore extends within the socket) and out of the window, the applicator is advanced into the patient. This is preferably done through whatever path the suture was retrieved through, including the working channel



of an endoscope or outside an endoscope. The applicator is advanced until the hood contacts the tissue, the suture is tensioned, and then the handle is operated to secure the cinch on the suture as follows.

In accord with the invention, when a sufficient force is applied at the handle to move the handle from the second position into a third position (with the second handle member in a relatively proximal location relative the second position), the bead **126** is drawn proximally into the space between the axial wall **142** and the ribs **34**. As noted above, this space is too small to receive the bead **126**. However, as shown in FIGS. **11**, **12** and **13**, the ribs **34a**, **34b**, **34c** are adapted in structure to sequentially deform into the pathway **30** of the cinch under a defined force so as to securely contact the suture **32** and thereby lock the cinch onto the suture. To facilitate application of the force, the axial wall **142** is positioned and oriented to guide the bead **126** linearly and axially relative to the longitudinal axis  $A_L$  of the tubular member as the second handle member **114** is moved relatively proximal toward the first handle member **112** into the third position. However, this linear retraction is at an angle relative to the ribs **34**. This results in the bead **126** applying a deformation force against the ribs **34** that increases with each proximally subsequent rib (increasing from rib **34a** to rib **34b** to rib **34c**). Referring to FIG. **13**, where the cinch **10** defines a suture cutter tab **42**, as the bead **126** is drawn proximally along the cinch, the bead **126** displaces the suture cutter tab **42** to cause it to cut the suture. This is preferably caused by the tongue-like projection **40** on deformed rib **34c** contacting the cutter tab **42** to effect the displacement. Referring to FIGS. **13**, and **14**, after the cutter tab **42** has severed the suture **32**, the applicator **100**, and thus housing **106**, may be retracted relative to the tissue **150** and any other structure (such as a suture tag or releasable suture needle **152**) securing another portion of the suture within the tissue, and the cinch is thereby released from the housing **106** of the applicator.

The movement of the handle **102** from the second position to the third position at which complete deformation of the ribs and cutter tab **42** displacement occurs preferably is a continuous process. FIG. **15** illustrates load on the shaft **110** as the ribs **34** are deformed in sequence. It is noted that the load increases as each subsequent rib is deformed. The system is designed to require a load of less than 15 lb-f to deform the ribs and move the cutter tab **42** to cut the suture, and subject the shaft to a tensile extension of less than 0.08 inches at such maximum load. Less preferably the system can be required to operate with greater loads; however, such may require use of stronger shaft materials and can be more difficult to manually operate to deform the cinch and cut the suture.

Turning now to FIG. **16**, in accord with another aspect of the invention, in an embodiment in which the cinch **10a** does not define an integrated cutter, the cinch applicator is provided with suitable cutter **160** to cut the suture **32** after the cinch is secured on the suture. By way of example only, such cutter **32** is one that can be moved relative to the window **144** in the housing **106** in a longitudinal or rotational manner, or a punch that is sufficiently movable through the window to sever the suture extending through the window from the suture attached to the cinch and tissue. In the example shown in FIG. **17**, the cutter **160** is longitudinal displaceable across the window **144** to cut the suture. Such displacement is actuated by operation of the handle **102**.

With reference to the following description of the cinch loader **200**, the terms “proximal” and “distal” are defined with respect to the loader being located in a coupled rela-

tionship at the distal end of the applicator, where it is used to load a suture cinch into the applicator, as now described. The use of the loader is particularly advantageous, as the cinch is particularly small, thereby rendering it somewhat impractical for manipulation into the proper orientation into the housing solely by the fingers of an operator. The loader can be provided preloaded with a cinch or can be operator-loaded with a cinch from a store of cinches for subsequent loading of the cinch into the applicator.

Referring now to FIGS. **18** and **19**, the loader **200** includes a body **202** preferably having a convexly arced upper surface **204** and defining a lower surface **206** with a recess **208** for a finger holed. The shape is well-adapted for comfortable and stable handling by the operator. The body **202** defines a straight throughbore **210** defining a longitudinal axis  $A_L$  that extends through the body, and a suture guide slot **212**. The throughbore **210** has distal (first), central, and proximal (second) portions, respectively **214**, **216**, **218**. The distal portion **214** of the throughbore **210** has a non-circular and preferably square cross-sectional shape in a direction transverse to the longitudinal axis  $A_L$ . The central portion **216** is relatively smaller in diameter and preferably has a circular cross-sectional shape transverse to the longitudinal axis  $A_L$ . The proximal portion **218** has a shape and size corresponding to the distal end of the housing **106** of the applicator **100** and particularly the hood **130** thereof so that the hood may be stably inserted and retained therein (see FIG. **9**). To that end, the proximal portion **218** has a concavely curved wall **220** and an opposed flat wall **222**. The suture guide slot **212** extends along the exterior upper surface **204** of the body **202** and leads into the proximal portion **218** of said throughbore interrupting the flat wall **222**. The guide slot **212** is an open structure.

Referring to FIGS. **19** and **20**, a cinch pusher **224** and a cinch **10** are longitudinally displaceable within the central portion **216** of the throughbore. The cinch pusher **224** has a proximal end **226** and distal end **228**. The proximal end **226** of the pusher defines a first tip portion **230** provided with a shape, e.g., a hook, such that it engages the lateral entry opening **22** in the cinch **10** to retain the cinch within the central portion **216** of the throughbore **210** under tension, and a second tip portion **232** that butts against the first end **16** of the cinch and having a shape suitable for applying a pushing force thereagainst under compression, e.g., an orthogonal face. In a cinch-loaded configuration, with the lateral entry **22** opening of the cinch engaged by the first tip portion **230**, the second end **20** of the cinch (e.g., from and proximal the exit opening of the cinch) extends into the proximal portion **218** of the throughbore to facilitate loading the cinch into the housing **106** of the applicator, as described below. Further, the engagement of by the first tip portion **230** cants the cinch **10** onto the first side **24** of the first portion **14** thereof to raise the second end **20** of the cinch to also facilitate loading the cinch onto the hood **130** and into the socket **132** of the applicator **100**.

A button **234** is displaceable within the distal portion **214** of the throughbore and is rotationally fixed to the distal end **228** of the pusher **224**. The button **234** is provided with a shape that rotationally interferes with the distal portion **214** of the throughbore; this limits rotation of the first tip portion **230** of the pusher and thus stabilizes the orientation of the cinch **10**. The button **234** may assume the shape of a rectangular solid or another suitable shape, and the shape thereof may be dependent on the shape of the distal portion **214** of the throughbore **210**. Other means may be used to limit rotation of the pusher and/or the cinch. The button **234**, in an initial position, extends partially out of the distal



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portion 214 of the throughbore so that it can be contacted and displaced proximally by a finger of an operator.

Turning to FIG. 21, the hood 130 of the housing 106 is received into the proximal portion 218 of the throughbore 210 such that once fully inserted, the cinch 10 is aligned for advancement into the hood 130 and the socket 132. Referring to FIG. 22, then, the button 234 is pushed relative to the body 202 causing the second tip portion 232 to advance the cinch 10 into the hood 130 and socket 132, with the entry opening 22 of the cinch facing the open side of the hood 130 and the exit opening 26 of the cinch 10 aligning with the window 144 of the housing 106. The extent of longitudinal displacement of the button 234, and thus the displacement of the cinch 10, is limited; the button bottoms out against a shoulder 236 defined by the transition between the distal and central portions 214, 216 of the throughbore (FIG. 19).

Turning now to FIG. 23, once the loader 200 is operated to advance the cinch 10 longitudinally into and in proper alignment with the housing 106, the suture guide slot 212 is utilized to facilitate feeding the suture 32 into the entry opening 22, through the pathway 30, and out of the exit opening 26 of the cinch, as well as out of the window 144 of the housing. (See FIGS. 10 and 22 for details of the described pathway) As shown in FIG. 24, after the suture 32 has been fed through the intended pathway in the cinch and housing, the open structure of the slot 212 allows the suture 32 to be pulled away from the loader 200, or the loader to be uncoupled from the applicator 100 and the loader to be pulled away from the suture 32.

In use, the handle 102 of the applicator 100 is operated to advance the bead 126 at the distal end of the shaft 110 to a location sufficient distal of the socket to permit loading of a cinch. The hood 130 is then advanced into a cinch-loaded loader 200, button 234 of the loader is operated to load the cinch 10 into the housing 106, the handle 102 of the applicator is operated to retract the bead 126 proximally to engage and restrain the cinch relative to the housing, and the suture 132 is fed through the cinch 10 and out of the window 144 of the housing. The loader 200 is then uncoupled from the housing 106 of the applicator 100.

The described system has particular use in endoscopic procedures, in a natural orifice procedure in which an endoscopic stitching instrument has applied one or more stitches of suture through tissue, in a procedure on gastrointestinal tissue where it is necessary or desirable to secure one or more sutures, or in any other endoscopic procedure where it is necessary or desirable to secure one or more sutures. In a mode of such stitching, a needle fixed to one of the suture is advanced through the tissue and carries the suture through the tissue. Once the tissue is sufficiently stitched to approximate the tissue, the cinch applicator loaded with a cinch, in accord with the above, is provided for cinching the suture against the tissue and/or relative to the suture needle. Subsequently, the cinch applicator may be withdrawn from the patient, a new cinch may be loaded into the cinch housing, preferably through use of the cinch loader, and the cinch applicator can be used again to secure an addition suture. The process may be repeated as necessary.

There have been described and illustrated herein embodiments of a cinch applicator and a method of applying a cinch. While particular embodiments of the invention have been described, it is not intended that the invention be limited thereto, as it is intended that the invention be as broad in scope as the art will allow and that the specification be read likewise. Thus, while particular dimensions have been described for the cinch and angles have been described

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with respect to portions of the cinch applicator, it will be appreciated that other suitable dimensions and angles for the components can be used as well. Also, while preferred materials are described, it is appreciated that other materials can be used. In addition, while the applicator has been described with respect to a flexible tubular member and shaft, which make the applicator ideally suited for insertion through the working channel of an endoscope that can be bent through an arc of up to 180°, the applicator alternatively may be assembled with a rigid tubular member and flexible or rigid shaft rendering the applicator more suitable for laparoscopic or open surgery. In each of such laparoscopic and open uses, the cinch can be of an appropriately larger size. It will therefore be appreciated by those skilled in the art that yet other modifications could be made to the provided invention without deviating from its scope as claimed.

What is claimed is:

1. A cinch for a cinch applicator for securing suture to a tissue, the cinch applicator having a tubular member with a distal housing in which the cinch can be seated, and a shaft displaceable relative to the tubular member and having a force-applying member at its distal end, said cinch consisting of:

a unitary tubular element defining a longitudinal axis, a first longitudinal portion defining a first end of said tubular element, a second longitudinal portion opposite said first longitudinal portion and defining a second end of said tubular element, a periphery having a first hemi-tubular portion and an opposite second hemi-tubular portion, an entry opening in the first hemi-tubular portion to a first side of the longitudinal axis and at said first portion, an exit opening in the second hemi-tubular portion to an opposite second side of the longitudinal axis, said entry and exit openings facing in opposite directions, a suture pathway defined from said entry opening and through said exit opening, at least one plastically deformable rib defined in said second longitudinal portion and extending at least partially about said first hemi-tubular portion transverse to said longitudinal axis, and a seat adapted to receive a portion of said force-applying member in said first hemi-tubular portion between said entry opening and said at least one deformable rib,

wherein when the suture is extending through said entry opening, said pathway, and out of said exit opening, and

when said force-applying member is forcibly retracted from said seat and into contact with said at least one rib, said at least one rib is adapted to plastically deform to secure said suture within said pathway.

2. A cinch according to claim 1, wherein: said periphery is round.

3. A cinch according to claim 1, wherein: said at least one rib is a plurality of ribs, and said ribs are configured to be plastically deformed in sequence upon being subject to a longitudinal deformation force along an exterior of said periphery at said second longitudinal portion in a direction from said first end to said second end.

4. A cinch according to claim 3, wherein: said ribs are obliquely oriented relative to the longitudinal axis.

5. A cinch according to claim 4, wherein: said ribs are defined by laser cut slots about said periphery of said tubular element.



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6. A cinch according to claim 4, wherein:  
said ribs each have a leading end oriented toward said first  
end of said tubular member, and a trailing end oriented  
toward said second end of said tubular member, and  
said leading end is defined by a curvilinear surface and  
said trailing end is defined by straight surfaces. 5
7. A cinch according to claim 1, wherein:  
said first longitudinal portion at said second hemi-tubular  
portion of said periphery includes an exterior surface  
oriented obliquely relative to said longitudinal axis and  
extending to the first end. 10
8. A cinch according to claim 1, wherein:  
said entry opening is elongate, having a first edge nearer  
said first end and a second edge nearer said second end.
9. A cinch according to claim 8, wherein:  
said second hemi-tubular portion at said first longitudinal  
portion is provided with an exterior surface oriented  
obliquely relative to said longitudinal axis, and said  
exterior surface extends from said first end to proxi-  
mate said second edge of said entry opening. 20
10. A cinch according to claim 1, wherein:  
said tubular element includes an integral tab extending  
into said pathway to deflect said suture from said  
pathway toward said exit opening.
11. A cinch according to claim 1, wherein: 25  
said tubular element includes an integral tab extending  
from said second hemi-tubular portion and into said  
pathway, said tab adapted to be plastically deformed  
toward said exit opening and cut the suture passing  
through said exit opening when the force-applying 30  
member is forcibly retracted past said at least one rib  
and into contact with said tab.
12. A cinch according to claim 1, wherein:  
said tubular element is metal.
13. A cinch according to claim 1, wherein: 35  
said tubular element is a portion of a hypotube.
14. A cinch according to claim 1, wherein:  
said tubular element has a length not exceeding 15 mm  
and diameter not exceeding 1.5 mm.
15. A cinch for a cinch applicator for securing suture to a 40  
tissue, the cinch applicator having a tubular member with a  
distal housing in which the cinch can be seated, and a shaft  
displaceable relative to the tubular member and having a  
force-applying member at its distal end, said cinch consist-  
ing of: 45
- a unitary tubular element defining a longitudinal axis, a  
first longitudinal portion defining a first end of said  
tubular element, a second longitudinal portion opposite  
said first longitudinal portion and defining a second end  
of said tubular element, a periphery having a first 50  
hemi-tubular portion and an opposite second hemi-  
tubular portion, an entry opening in the first hemi-  
tubular portion to a first side of the longitudinal axis  
and at said first portion, an exit opening in the second  
hemi-tubular portion to an opposite second side of the 55  
longitudinal axis, said entry and exit openings facing in  
opposite directions, a suture pathway defined from said  
entry opening and through said exit opening, at least  
one plastically deformable rib defined in said second  
longitudinal portion and extending at least partially 60  
about said first hemi-tubular portion transverse to said  
longitudinal axis,  
a tab extending from said second hemi-tubular portion  
at said second longitudinal portion of said tubular  
element and into said pathway, 65
- wherein when the suture is extending through said  
entry opening, said pathway, and out of said exit

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- opening and when the force-applying member is  
forcibly retracted into contact with said at least one  
rib, said at least one rib is adapted to plastically  
deform to secure the suture within said pathway, and  
said tab is adapted to be moved toward said exit  
opening and cut the suture passing through said exit  
opening.
16. A cinch according to claim 15, wherein:  
said first hemi-tubular portion at said second longitudinal  
portion includes an integral seat between said entry  
opening and said at least one deformable rib, said seat  
adapted to receive a portion of said force-applying  
member.
17. A cinch for a cinch applicator for securing suture to a  
tissue, the cinch applicator having a tubular member with a  
distal housing in which the cinch can be seated, and a shaft  
displaceable relative to the tubular member and having a  
force-applying member at its distal end, said cinch compris-  
ing of:
- a unitary tubular element defining a longitudinal axis, a  
first longitudinal portion defining a first end of said  
tubular element, a second longitudinal portion opposite  
said first longitudinal portion and defining a second end  
of said tubular element, a periphery having a first  
hemi-tubular portion and an opposite second hemi-  
tubular portion, an entry opening in the first hemi-  
tubular portion to a first side of the longitudinal axis  
and at said first portion, an exit opening in the second  
hemi-tubular portion to an opposite second side of the  
longitudinal axis, said entry and exit openings facing in  
opposite directions, a suture pathway defined from said  
entry opening and through said exit opening, at least  
one plastically deformable rib defined in said second  
longitudinal portion and extending at least partially  
about said first hemi-tubular portion transverse to said  
longitudinal axis,  
a tab integral with said tubular element and extending  
into said pathway to deflect said suture from said  
pathway toward said exit opening,  
wherein when said suture is extending through said  
entry opening, said pathway, and out of said exit  
opening and when the force-applying member is  
forcibly retracted into contact with said at least one  
rib, said at least one rib is adapted to plastically  
deform to secure said suture within said pathway,  
and at least one of said at least one rib is further  
adapted to contact said tab and displace said tab to  
cause said tab to sever said suture exiting through  
said exit opening.
18. A cinch according to claim 17, wherein:  
said first hemi-tubular portion at said second longitudinal  
portion includes an integral seat between said entry  
opening and said at least one deformable rib, said seat  
adapted to receive a portion of said force-applying  
member.
19. A cinch for a cinch applicator for securing suture to a  
tissue, the cinch applicator having a tubular member with a  
distal housing in which the cinch can be seated, and a shaft  
displaceable relative to the tubular member and having a  
force-applying member at its distal end, said cinch compris-  
ing:
- a unitary tubular element defining a longitudinal axis, a  
first longitudinal portion defining a first end of said  
tubular element, a second longitudinal portion opposite  
said first longitudinal portion and defining a second end  
of said tubular element, a periphery having a first  
hemi-tubular portion and an opposite second hemi-

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tubular portion, an entry opening in the first hemi-  
 tubular portion to a first side of the longitudinal axis  
 and at said first portion, an exit opening in the second  
 hemi-tubular portion to an opposite second side of the  
 longitudinal axis, said entry and exit openings facing in 5  
 opposite directions, a suture pathway defined from said  
 entry opening and through said exit opening, at least  
 one plastically deformable rib defined in said second  
 longitudinal portion and extending at least partially  
 about said first hemi-tubular portion transverse to said 10  
 longitudinal axis,

wherein when said suture is extending through said  
 entry opening, said pathway, and out of said exit  
 opening, and

when said force-applying member is forcibly retracted 15  
 into contact with said ribs, said ribs are adapted to  
 plastically deform to secure said suture within said  
 pathway.

**20.** A cinch according to claim **19**, wherein:

said first hemi-tubular portion at said second longitudinal 20  
 portion includes an integral seat between said entry  
 opening and said at least one deformable rib, said seat  
 adapted to receive a portion of said force-applying  
 member.

\* \* \* \* \*

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